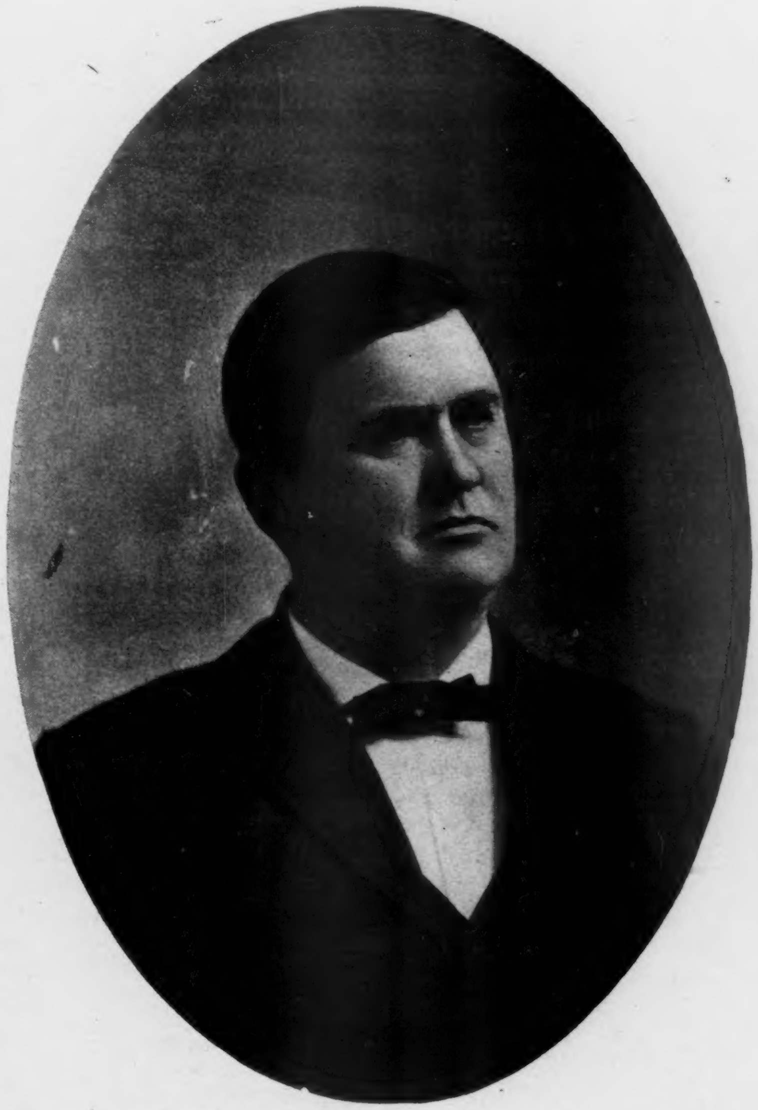
(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL.

J. F. DEEMS.

The appointment of Mr. Deems to the newly created position of General Superintendent of Motive Power of the Vanderbilt Lines is one which it is a pleasure to announce, not only because of the fitness of the selection, but because of the far-reaching and broad-minded policy of which the appointment is a part. It is not alone a recognition of the growing importance of motive power problems, it is a significant indication of appreciation of the possibilities of advantage to be had by drawing together to one general officer the engineering, operating and commercial responsibilities of the motive power branch of the operation of a combination of railroads. In such a policy the allied Vanderbilt roads inaugurate a plan which will bring to the owners results of the concentration of ownership, which could not otherwise be obtained. The widely different ideas of the individual officers of allied lines like these, as expressed in practice, result in large expenditures which might be saved by uniformity of construction and methods of handling motive power matters. No one can predict the value of this step to these roads. It is a business move which is entirely in accord with the spirit of the times and one which will, unquestionably, bring most important and far-reaching results similar to those obtained by concentration so often seen in connection with large industrial combinations.



J. F. DEEMS.

Some months ago the mechanical officers of the New York Central, the Lake Shore, the Big Four, Michigan Central, Boston & Albany, Nickel Plate, P. & L. E. and Lake Erie & Western—all closely related lines—formed an association to confer upon questions relating to equipment with a view of establishing uniform practice and avoiding the unnecessary differences in present construction which characterized the individual railroads, the underlying idea being to work toward a reduction of construction to a common system to be adopted by all. These roads operate 10,000 miles in a territory of the densest traffic; tney include 3,625 locomotives, 3,602 passenger and 148,105 otner cars. This organization, of which Mr. A. M. Waitt is Chairman and Mr. F. M. Whyte secretary, has already accomplished a number of standards and now has several important problems under way, such, for example, as the pooling of freight equipment. The appointment of Mr. Deems is an outgrowth of this plan and it places a general officer over the strictly Vanderbilt lines. In its scope and possibilities the position is unique in this country and it is believed that there is none like it in the world. The responsibilities of Mr. Deems will reach far beyond the material to the personnel. It is understood that he will direct the various motive power departments of these roads, which is a task requiring the best knowledge of the work, the most careful and accurate judgment and the widest experience.

Mr. Deems comes to his new office thoroughly understanding his problem and after an extended experience, which, in addition to his railroad work, includes the direction of next to the largest locomotive building establishment in the country. In this way he combines railroad and commercial experience, without which no one would attempt such responsibilities. There is probably no line of industry so greatly in need of the application of business principles than the part of railroad operation which deals with locomotives. The establishment of this office is, therefore, considered as the beginning of a new era in motive power matters and its effect upon the future cannot be estimated.

Mr. Deems is 46 years of age. He was born in Brownsville, Pennsylvania, and is a graduate of the South Western Institute of that State. At various times while obtaining his education he "taught school." His first railroad work began with his apprenticeship on the Baltimore & Ohio, where he later served as a machinist. About 15 years ago he went to the Chicago, Burlington & Quincy as a machinist in the shops

at Beardstown, Ill. Eight months later he became gang foreman and then roundhouse foreman. His next step was to the position of roundhouse foreman at Galesburg, Ill., the most important division point on the road. He next returned to Beardstown as general foreman and was soon made master mechanic at Ottumwa, Ia. Then he went back to Beardstown in the same capacity, where he remained until called to succeed the late Joel West as master mechanic at West Burlington. It was here that he did his most important work on this road. He established piecework on a new basis and it spread from there all over the system. He has the faculty of discovering ability in young men, and it was this faculty which made him so strong on this road. Two years ago he was appointed to the position of assistant superintendent of motive power and soon succeeded Mr. Delano as superintendent of motive power. Ten months ago he was called to the position of general superintendent of the Schenectady Works of the American Locomotive Company, a position which he has filled with ability and success.

The success of Mr. Deems is the result of his ability and personality. He takes a personal interest in every man under him and the humblest day laborer is not beneath his notice. He has repeatedly said to the writer: "Humble work does not necessarily take from any man any element of manhood." He is always approachable and his office is always open to any subordinate of any degree who comes with a claim of injustice. While always accessible, genial and friendly, his experience is such that no workman can deceive him. With all these traits, authority and discipline do not suffer. In his article in our June number of last year he gave the following expression: "There is no authority worthy the name except that which secures voluntary service; there is no official dignity except that which is based on the love and respect of the subordinate for the superior, and if the railroads could to-day measure in dollars and cents the exact cost of this so-called authority or official dignity, they would probably find it a liability of much greater magnitude than they now realize."

A friend and associate in his work, who has been close to him for fifteen years, expressed the following view of the secret of the success of Mr. Deems:

"It is his absolute loyalty to his friends and his love for his work and his associates. This means all the men who are working for him, from the humblest to the highest. It comes from the heart—it is not 'put on,' he really means it. He treats the men under him always as a gentleman, never losing his temper, and he is happiest when he can do some personal favor for them. These many traits of character are what make him so popular with the men and such a good executive. He gets their voluntary support, and, after all, it is voluntary support that makes any man and not the support which is given for any other consideration."

The starting of large gas engines has presented an interesting problem. A newly developed oil engine built by the Campbell Gas Engine Company, of Halifax, England, is started by high-pressure burnt gases stored in a cylinder or bottle which is charged from the gas engine cylinder through a pipe connecting the storage cylinder with the combustion space of the engine cylinder. When an explosion takes place in the engine cylinder the pressure forces some of the burnt gases through the pipe into the storage bottle at a pressure of about 150 lbs. per square inch. A check valve holds this pressure in the bottle and its capacity is sufficient to start the engine three or four times without recharging. The recharging, however, takes place automatically whenever the engine is running. This engine is described in The Engineer, of London.

THE COMPOUND LOCOMOTIVE AND ITS DEVELOPMENT IN FRANCE.

BY A. HERDNER.

Assistant Chief Engineer of Motive Power and Rolling Stock.

SOUTHERN (MIDI) RAILWAYS OF FRANCE.

(Concluded from Vol. LXXVI, Page 386.)

An element evidently very important in compound locomotives, and which cannot be governed by any definite formula, and in the determination of which the sagacity of the designer necessarily plays an important part, is the ratio of volumes of high and low pressure cylinders that is best to adopt. However, the magnitude of this ratio must be considered as intimately related to the general data and design of the locomotive. About twelve years ago, at the time when the compound locomotive had become the live subject in France, I tried to treat the above question by calculation, and here is the method I have followed:

Let us consider steam admitted into a high-pressure cylinder of a compound locomotive with a given expansion under the absolute pressure P and exhausting from the low-pressure cylinder under the atmospheric pressure H. If the cylinder clearance and initial condensation be neglected it is evident that the manner of the steam utilization will be entirely defined by the three ratios:

K = ratio of the cylinder volumes.

f = degree of admission into high-pressure cylinder.

F = degree of admission into low-pressure cylinder.

Three equations being necessary to determine the three ratios, we can propose to satisfy ourselves with three distinct conditions that we choose among the most probable that will assure an economical or advantageous performance.

The first condition that comes to our mind consists in the realization of a given degree of total expansion, D, this being the ratio of initial volume of steam to the final volume. This condition is written as follows:

$$f = KD \qquad (1)$$

Another condition, which at present it does not appear advantageous to completely realize, but which answered well to the exigencies of the time, is expressed in the equation:

$$FK = 1 \qquad (2)$$

which signifies that there will be no fall in the pressure in the receiver, whose capacity, however, is supposed to be very large.

For the third condition we can assume that the work developed in each pair of cylinders is equal among them. From this we write the equation:

$$\text{Log.}_e \frac{F}{f} = \frac{1}{KF} - \frac{hk}{Pf} \qquad (3)$$

But it may be more interesting to ascertain rather than the equality of work the equality of maximum forces to which the parts of transmission of the propelling mechanism are subjected. In that case the equation (3) can be substituted by the following:

$$\frac{h}{P} K^2F + K(F - f) - f = 0 \qquad (4)$$

Finally we can simply propose to realize the equality of degrees of admission in each of the two cylinders; then the third condition can be expressed as follows:

$$F = f \qquad (5)$$

The determination of the correlative values of K, f, F will result, then, according to the choice that will be made from among the last three expressions, from the simultaneous resolution of one of the groups of the following equations: (1, 2. 3), (1, 2, 4), (1, 2, 5).

Geometrically the problem will consist (see Fig. 5) in dividing a combined steam diagram A B C D E by a parallel line I H to A B and E D, and this is what would result accordingly: Area ABHI = Area IHCDE, or AI × IH = IE × ED, or finally $(IH)^2 = AB \times ED$.

When it concerns an engine with a variable expansion, and in particular a locomotive, the method that we have just indicated can evidently be applied only to the normal position of the lever; that is to say, to the working cut-off in the cylinders. For any other position of the lever, K being determined and f becoming an independent variable, we can, nevertheless, propose to establish between f and F a certain relation destined to derive, for all positions of the reverse lever, the benefit of one or the other of the last two conditions that have been sought for the normal position of the reverse lever. If it is considered that condition (5) does not present any interest unless it can be satisfied for all degrees of admission, we are thus led to consider five different solutions that can be represented by the following symbols:

$$\frac{1,\ 2,\ 3,}{2} \quad \frac{1,\ 2,\ 3,}{3} \quad \frac{1,\ 2,\ 4,}{2} \quad \frac{1,\ 2,\ 4,}{4} \quad \frac{1,\ 2,\ 5,}{5}$$

and to several which correspond, as far as the distribution is concerned, to arrangements that were and are yet actually applied.

The study of these combinations, not coming entirely within the scope of this article, and presenting to-day an interest rather retrospective, we will limit ourselves to indicating a few numerical results obtained by means of our formulæ for the normal position of the reverse lever:

	K	f	F
Equality of work	1.67	0.334	0.599
Equality of maximum forces	1.96	0.392	0.509
Equality of admissions	2.24	0.447	0.447

The examination of the above formulæ shows that if all things are otherwise equal, P increases the values of K corresponding to the equality of forces, or slightly diminishes the equality of work, while the values corresponding to the equality of admissions remain invariable. If all things are otherwise equal and the total expansion is increased, the values found for K increase quite rapidly. In particular, if the expansion is sufficiently prolonged to have the steam exhaust at the atmospheric pressure the three values for K are intermixed in such a manner that the quality of work, equality of forces and that of admissions are realized simultaneously. In practice it will be admitted that by increasing P there should be a corresponding increase in the total degree of expansion in such a manner that there should be very nearly

$$PD = \text{constant}.$$

Let us consider, in this hypothesis, the case where P = 15 kilograms (15 kilograms is equivalent to 213.34 lbs.) pressure per square inch, and, consequently, $D = \frac{1}{6.25}$. The values of K, f and F will then become the following:

	K	f	F
Equality of work	1.88	0.300	0.532
Equality of maximum forces	2.23	0.356	0.448
Equality of admissions	2.50	0.400	0.400

Thus, as we have already remarked, experience has shown that a moderate fall of pressure in the receiver is not only without disadvantage, but actually presents a real advantage. Instead of expressing that this fall of pressure is naught, we could perhaps be led to assume that it has a determined value, c; equation (2), above evolved, can be now replaced by the following:

$$Pf - \frac{Pf}{Kf} = C \text{ .... (2 bis)}$$

Let us take as before P = 15 kilograms and $D = \frac{1}{6.25}$, and we will make c = 1 kilogram (1 kilogram = 14.22 lbs. per square inch). The values formed under these conditions for these three ratios are those indicated below:

	K	f	F
Equality of work	2.28	0.365	0.537
Equality of maximum forces	2.50	0.400	0.480
Equality of admissions	2.70	0.433	0.433

Although the above figures, taken as a whole, approach very nearly the coefficients actually employed in practice, they cannot of course serve any other purpose than a simple indica-

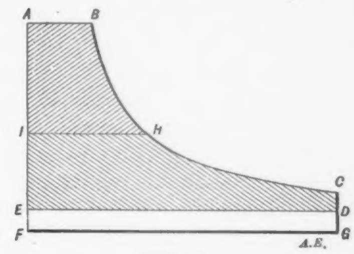


FIG. 5.

tion. We believe, however, to be able to make from the above the following legitimate conclusion: *First, that for higher values of initial boiler pressure it is best to employ greater values for K; second, that the values attributed to K should increase with the allowable theoretical increase of the fall of pressure in the receiver; third, that the condition of the equality of work is that which gives the least values for K; fourth, and finally, that the condition of the equality of degrees of admissions is that which allows us to adopt for K the greatest values.*

It is explained from the above why—for the four-cylinder locomotives of the first and second category, in which the steam distribution in each pair of cylinders is governed by a common valve or by two valves mounted on one valve stem (the tandem compound)—the values for K were generally made relatively high. It is thus that we find in the locomotives of the Plant System of Railways and the one of the Wisconsin Central (proposed), to cite only the most recent examples, the values for K equal to 2.77 and to 2.70 respectively.

It is not to be understood that the equality of admission in these locomotives is to be an inevitable consequence of their style of construction. [Because of having one common valve for one high and one low pressure cylinder.—Editor.] The high and low pressure laps on those valves need not necessarily be equal and a slight difference, which actually exists, of ⅛ in. in the Vauclain compound locomotive for the Plant System of Railways and about 3-32 in. in the Wisconsin Central Railway locomotive, is perfectly allowable. But since the sum of the lap and linear advance of admission is always the same for both cylinders, these differences are necessarily very limited in practice.

It is evident that a four-cylinder compound locomotive, like the one of Mr. Webb, in which K = 1.867, could not adapt itself to a similar distribution. Mr. Webb has correspondingly arranged his valves on two separate valve rods connected with each other by a third horizontal lever with unequal arms. The valves have thus two different travels, but as it is the throw of the eccentric that gives the actual movement to the valve, which is always the same for both valves, it can easily be conceived that a similar interdependence may be considered disadvantageous.

Mr. Von Borries, by employing the Walschaert valve motion with two pendulums, manages to give to his high and low pressure valves two different travels, both through the amplitude of the pendulum governed by the stroke and the throw of the eccentric, which give the actual travel to each one of them. Elegant as this solution may appear, t is nevertheless easy to understand that because of the arrangement of the

mechanism employed, these two elements of the valve distribution are geometrically combined in such a manner that they cannot be governed independently of each other, or for each of the two valves under consideration in particular.

The use of four valve motions governed by a single reversing mechanism seems to offer, in this respect, a much larger latitude in the sense that the choice of the most proper elements to assure a good steam distribution is only limited by considering the different positions of the reverse lever.

But all these solutions present one common disadvantage, resulting from the fact that all the different phases of the steam distribution in the low pressure cylinder, as well as those in the high-pressure cylinder, are entirely determined, whatever the speed may be, by the position of the reverse lever, that the amount of work to be furnished has led the engineer to adopt. Moreover, if we stop to consider, all other things being otherwise equal, how much the speed influences the shape of the steam diagram taken by a steam indicator, it will be admitted that the most complete and the most satisfactory solution concerning the steam utilization is the one adopted at the very first by Mr. de Glehn, and which consists in the division of the reversing gear. Thanks to this division, the engineer, without changing the admission in the H. P. cylinder, and consequently without modifying appreciably the quantity of steam consumed per stroke, can vary not only all the phases of the steam expansion in the L. P. cylinder, simultaneously as to the duration and importance of pressures in play, but also the governing pressure in the receiver, and consequently the back pressure in the high pressure cylinder. He is thus in a position even to combine between them whatever may be the amount of work to be developed, or whatever may be the speed at which that work is to be furnished, the degrees of admissions in the H. P. and L. P. cylinders found most advantageous—that is to say, those that will allow him to produce, with the same amount of steam consumed, the greatest quantity of work. We do not forget that this arrangement, which is mostly reproached for its complications, has often been criticised, especially in Germany and America. We confess not to understand the importance which was often attributed to these criticisms. The double reversing gear cannot appreciably increase the initial cost of the locomotive, nor the cost of repairs, and the advantages it affords, indisputable indeed, as far as economy and power developing is concerned, could have been very small indeed to compensate for so little an increase in cost. It will be objected that it leaves to the engineer too large an initiative, which he might abuse in combining irrationally the different degrees of admissions. This is not our opinion. We have, on the contrary, always noted that those interested in getting the most work out of their engine, interested in the economy of fuel, who year after year operate the same locomotive, and who have frequent occasions to mutually exchange observations, have come to adopt, in a measure, inevitably, even in the absence of comprehensive instructions, and oftentimes in spite of them, a way of running their engines most conforming to their interests, and consequently the most advantageous and most economical.

It has often been said that the compound locomotive is more susceptible to a poor steam distribution than the simple expansion locomotive. This is correct, and we cannot exercise too much care to especially note that in no case should the final pressure of the steam, compressed in the cylinder clearance space, particularly in the H. P. cylinder, attain so high a pressure as to be likely to interfere with the free movement of the engine.

Let us designate by U and u the volumes occupied by the steam at the beginning and the end of the period of compression. The final pressure, p, of the steam compressed in the high pressure cylinders will be expressed in the following equation:

$$P = \frac{U}{u} \times \frac{Pf}{Kf}$$

Where, after equation (2 bis)

$$P = \frac{U}{u} \times (Pf - c)$$

Three means are, therefore, at the disposal of the designer to reduce the value of P for the given values of P and f. 1st: u can be increased, which will necessitate principally increasing the cylinder clearance and incidentally the linear advance of the values.

2nd: U can be decreased by employing negative laps.

3rd: Finally, c, which, as is shown, represents the fall of pressure in the receiver, can be increased by giving longer admission to the lower pressure cylinder.

In practice two of the means are generally resorted to at the same time, and sometimes even all the three means; but as they all enter in very variable quantities, it results for the steam distribution in use in quite appreciable differences.

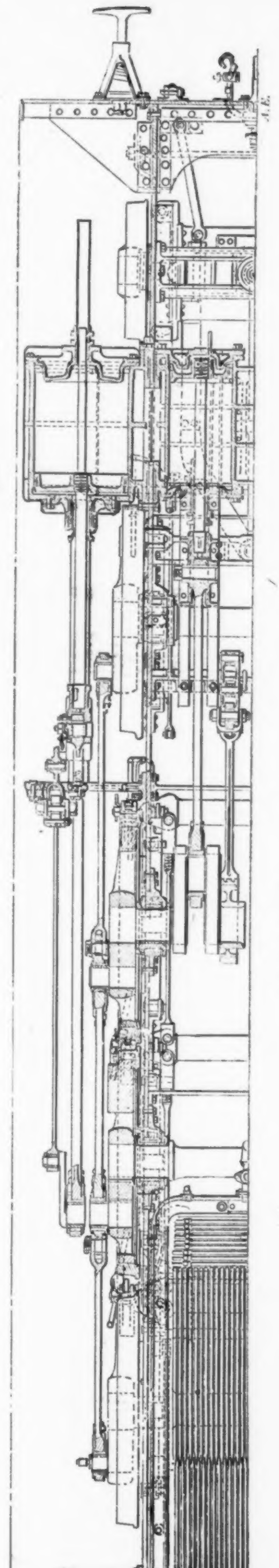
Mr. Von Borries, who has always avoided an excessive fall of pressure in the receiver, gives preference to the employment of the first two means. In this regard, he has established certain definite rules which consist in allowing a cylinder clearance of 12 per cent. of the cylinder volume, of inside negative laps equal to 20 per cent.—and even 25 per cent.—of the inside lap, and of linear advances of about 10 per cent. of the outside lap, the whole with a value of K not exceeding 2.25 and the valve gears arranged for a difference of about 0.10 between f and F for the usual cut-offs. These conditions, however, seem to apply mostly to the two-cylinder compounds having an initial pressure not exceeding 184.9 lbs.

The Northern Railways have also till quite recently allowed cylinder clearances of about 12 per cent. of the cylinder volume, but the inside negative laps of its valves were much less. On the other hand, the fall of pressure, relatively greater, that occurred in the receiver, did not show any appreciable disadvantage, especially at high speeds, because of having the valve gears entirely independent and left to the engineer all possibility to regulate the magnitude of this fall of pressure, according to the work to be done.

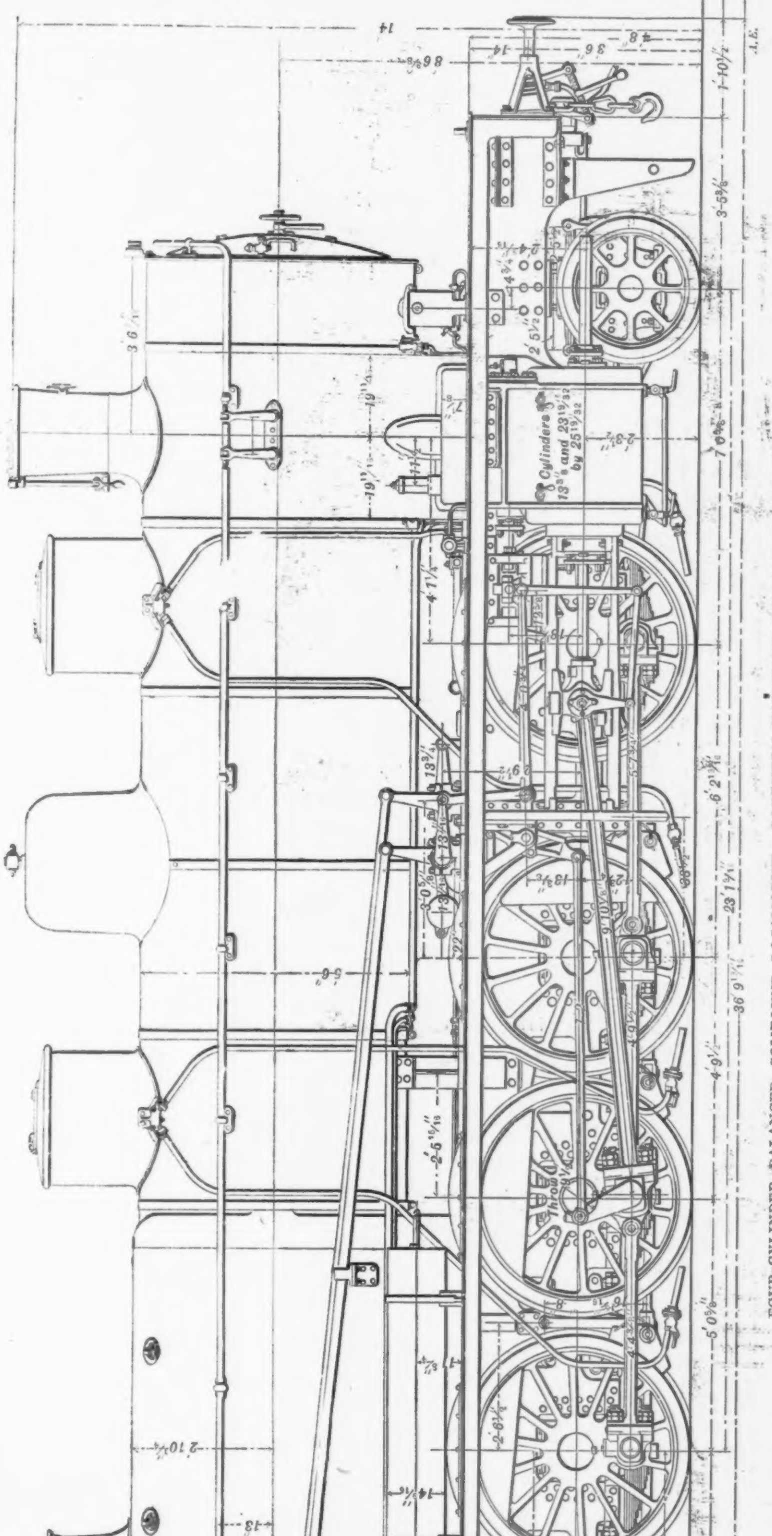
On the Paris, Lyons and Mediterranean Railways, where inside negative laps are not allowable, the third of the above named means is especially employed to reduce the final pressure of compression. This accounts for the special arrangement of the valve motions adopted by this company and which are made interdependent in such a manner as to mechanically assure a constant and prolonged admission in the lower pressure cylinders. Finally, on the Eastern Railways of France, where all three of the above means are made use of, it seems nevertheless that a certain preference is given to the first of them, since on its last built locomotives the cylinder clearance in the high pressure cylinders is as high as 20 per cent. of the cylinder volume. For the low pressure cylinders, which with reference to compressions are very much analogous to the cylinders of simple expansion locomotives,—a cylinder clearance of 7 per cent. to 8 per cent. of the cylinder volume can be used, like that in the simple engine, and with valves set for inside lap line in line or very small negative laps. In any event whenever an engine is designed to work with a very low pressure in the receiver, it may even be desirable to increase the above two elements.

Which among the diverse methods employed—all evidently being of a nature to insure a free steaming locomotive—are those which at the same time give the most economic performance of the steam consumed?

This question is rather difficult to answer *a priori*, and comparative experiences are only misleading. But what appears to us beyond doubt is that the common steam distributions for both high and low pressure cylinders are those that,

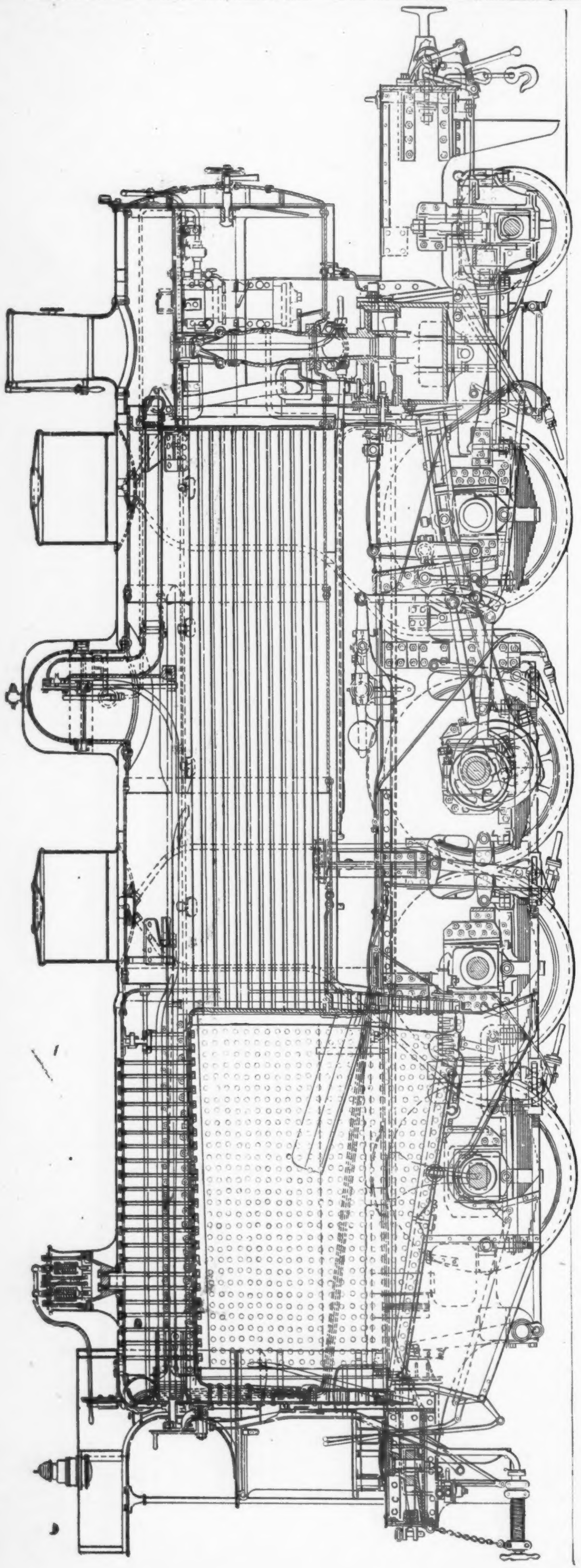


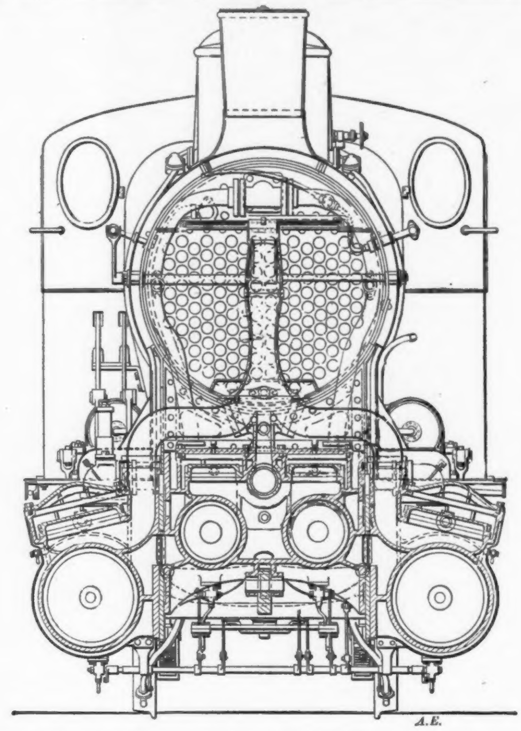
HALF PLAN.



FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE—SOUTHERN RAILWAYS OF FRANCE.

2—8—0 TYPE.





FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE—SOUTHERN RAILWAYS OF FRANCE.

because of the lesser number of elements that can be chosen by the designer, are least adaptable to the realization of the conditions most favorable to the best utilization of the steam at all positions of the reverse lever. The use of four distinct valves governed by a single reversing gear permit the designer to choose in the largest measure, among the means above indicated, those that appear to him most advantageous to regulate the compression phases. But when in this regulation the considerable influence of the speed is considered, whose effect may be equivalent to an increase of the initial volume U of the compressed steam, it is indispensable, in order to prevent the final pressure p from attaining in certain cases an excessive value, to be able to increase the value of c or the fall of pressure in the receiver.

In other words, this result cannot be obtained in practice unless we reserve for ourselves the means of varying the degree of admission F independently of tne admission f. In increasing F, not only the compression in the H. P. cylinder is reduced, but also that in the L. P. cylinder; it is with this fact that our engineers have become acquainted, more or less instinctively, inasmuch as they have got into the habit of giving, if not the ratio $\frac{f}{F}$, at least to the difference F — f, increasing values with the increase in speeds they wish to realize.

The description we have given above of the diverse methods employed to avoid excessive compressions shows clearly that the four-cylinder compound, although a more recent locomotive, has not benefited in a measure we were tempted to expect from the experience obtained previously with the two-cylinder compound in other countries. The four-cylinder compound has been developed for its own sake. The first locomotives (as the first two-cylinder compound locomotives) have been reproached in not being able to make speed, and it must be admitted that a certain number of locomotives, built after the time when the rules of Mr. Von Borries were already known, deserved this reproach, though in a very small degree. The splendid tests made by Mr. Barbier of the Northern Railways in 1897 under the direction of Mr. Du Bousquet, have enabled us to improve certain arrangements most adaptable to assure

to the four-cylinder compound locomotive a very free running and have given a most interesting series of results. Mr. Barbier, and Mr. Von Borries agree in their conclusions as to the advantage of large cylinder clearances and appropriate inside negative lap. Mr. Barbier recommends in addition the increase of the areas of steam, the volumes of steam chests, the section of the admission and exhaust ports and in general the suppression of every obstacle to the free circulation of the steam.

The experiments previously made by the Western Railways brought out the importance of the advantage in increasing the volume of the steam chests and the section of the steam pipes.

The splendid work recently performed by locomotive No. 2645 of the Northern Railways, which with a train, back of tender, of 196 tons, has covered a distance of 120 miles, between Paris and Arras, in 112 minutes—that is, at an average speed of 64.4 miles per hour—shows that the results sought have been attained in the largest possible measure. This performance is so much more remarkable from the fact that the long grades of ½ per cent. have been covered at a speed of 75 miles per hour, and even higher, and that higher speeds have not been made on down grades on account of train being ahead of time.

The four-cylinder compound locomotives which are at present employed in France, a great number of which have been designed by Mr. de Glehn, or built on the same principles, can be classified into five principal types:

(1) Fast passenger locomotives, 8-wheel, or generally known as the "American" type. This type of engine is at present employed by all railway companies, as well as by the State railways.

(2) Fast passenger locomotives of the "Atlantic" type. At present only the Northern Railways possess this type of locomotive, series Nos. 2641 and 2660. Similar locomotives are being built for the Southern and Eastern Railways and still other, more powerful, for the Paris-Orleans Railways.

(3) The 10-wheel type, first put in service in 1896 by the Southern Railways and which has since been reproduced by other railway companies and State railways with more or less important modifications, but which do not alter its general aspect.

(4) 8-wheel connected locomotives of the Paris, Lyons and Mediterranean Railways, a number of which have been transformed into 10-wheelers (of the type 3) by substituting a 4-wheel truck in place of the forward driver.

(5) The "Consolidation" type engine built in 1901 for the Southern Railways and of which there are so far but two locomotives, Nos. 4001 and 4002.

The first four types above defined are sufficiently known today to call for a more detailed description; but agreeable to the readers of the American Engineer and Railroad Journal, we attach to this article a photograph, principal data and a few general drawings of the engine No. 4001 of the Southern Railways.

These locomotives haul trains of 220 tons on 3.3 per cent. grades on the Beziers to Neussargues division with an equivalent kilometric consumption of steam and of slightly inferior kilometric consumption of coal than our older 8-wheel coupled locomotives, single expansion, and which cannot haul more than 159.8 tons on the same grades.

PRINCIPAL DATA OF LOCOMOTIVES NOS. 4001 AND 4002.
Southern Railways of France.

Boiler pressure	213.35 lbs. per sq. in.
Grate area	31 sq. ft.
Heating surface—	
Firebox	170 sq. ft.
Tubes	2,586 sq. ft.
Total	2,756 sq. ft.
Serve Tubes—	
Number	148
Outside diameter	3 ins.
Thickness	7-64 in.
Length between flue sheets	14 ft. 1 5-16 in.
Inside mean diameter of boiler	4 ft 11 9-16 ins.
Cylinders—	
Diameter of high pressure cylinder	15⅝ ins.
Diameter of low pressure cylinder	23 19-32 ins.
Stroke	25 19-32 ins.
Ratio of low to high pressure cylinder	2.360
Ratio of volume of receiver to that of both high pressure cylinders	1.740
Diameter of driving wheels	55⅛ ins.
Diameter of pony truck wheels	33½ ins.
Wheel base, distance from—	
Pony truck to forward driving axle	7 ft. ⅝ in.
Forward driving axle to H. P. main axle	6 ft. 2 13-16 ins.
H. P. main axle to L. P. main axle	4 ft. 9½ ins.
L. P. main axle to rear axle	5 ft. ⅝ in.
Total wheel base	23 ft. 1 9-16 ins.
Weight of locomotive light	142,340 lbs.
Weight in working order—	
First axle	15,400 lbs.
Second axle	35,530 lbs.
Third axle	35,530 lbs.
Fourth axle	35,530 lbs.
Fifth axle	35,530 lbs.
Total	157,520 lbs.
Adhesive weight	142,120 lbs.
Total length of engine	36 ft. 10 5-16 ins.

Editor's Note.—We are indebted to Mr. Charles M. Muchnic, formerly mechanical engineer of the Denver & Rio Grande Railway, for the translation of Mr. Herdner's article.

STARVING INJECTORS.

It is not unusual for a large locomotive injector to throw 3,500 to 4,500 gallons of water into a locomotive boiler in an hour and yet such delivery is expected to be provided for through pipes no larger than were formerly used in connection with injectors which would deliver but 2,000 gallons in that time.

While great progress has been made in connection with other parts of locomotives, the injector connections have not been given the attention which they deserve and the locomotive has fairly outgrown them. In many cases the old standards have remained the same for about 20 years, notwithstanding the fact that locomotives have been more than doubled in capacity in that time. With increased boiler capacity and high steam pressure it is necessary to use injectors which will deliver a great deal more water than that which formerly sufficed, and the time has come for a radical change in this practice.

There seems to be no reason why at least 3-in. smooth-bore hose should not be used to connect with the tender tank. With this a free opening of 2¾ ins. may be obtained in the fitting. A strainer at the valve in the tank well may be used and the conical strainer in the pipe removed. This would permit of using much larger channels for the water to the great relief of the injectors.

It is not enough to enlarge the suction side alone, the delivery pipes and checks also appear to need attention. The duplex check fitting supplied by the Brooks Works, which is shown in many locomotive engravings in this journal, seems to be a very good device, because it delivers all the water on one side of the boiler, which seems to be better practice than to enter it in two places and in two directions. This, however, is not the main point of this criticism. The free and unobstructed opening for the water is what is needed. A check that will lift but 1-16 in. for a No. 10 injector connected by a 2¼ in. pipe is not sufficient, yet this has been found in a recently built locomotive. Such an injector needs at least an even equivalent to a 2-in. hole. In one of the reports presented to the Master Mechanics' Association last June the following suggestions occur:

"As the water evaporation is heavy, a good inlet from tank to injector should be provided. A majority of the manufacturers prefer the following sizes of feed-pipe in connection with the different-sized injectors:

"No. 8, not less than 2 ins. internal diameter.

"Nos. 9 and 10, not less than 2½ ins. internal diameter.

"Nos. 11 and 12, not less than 3 ins. internal diameter.

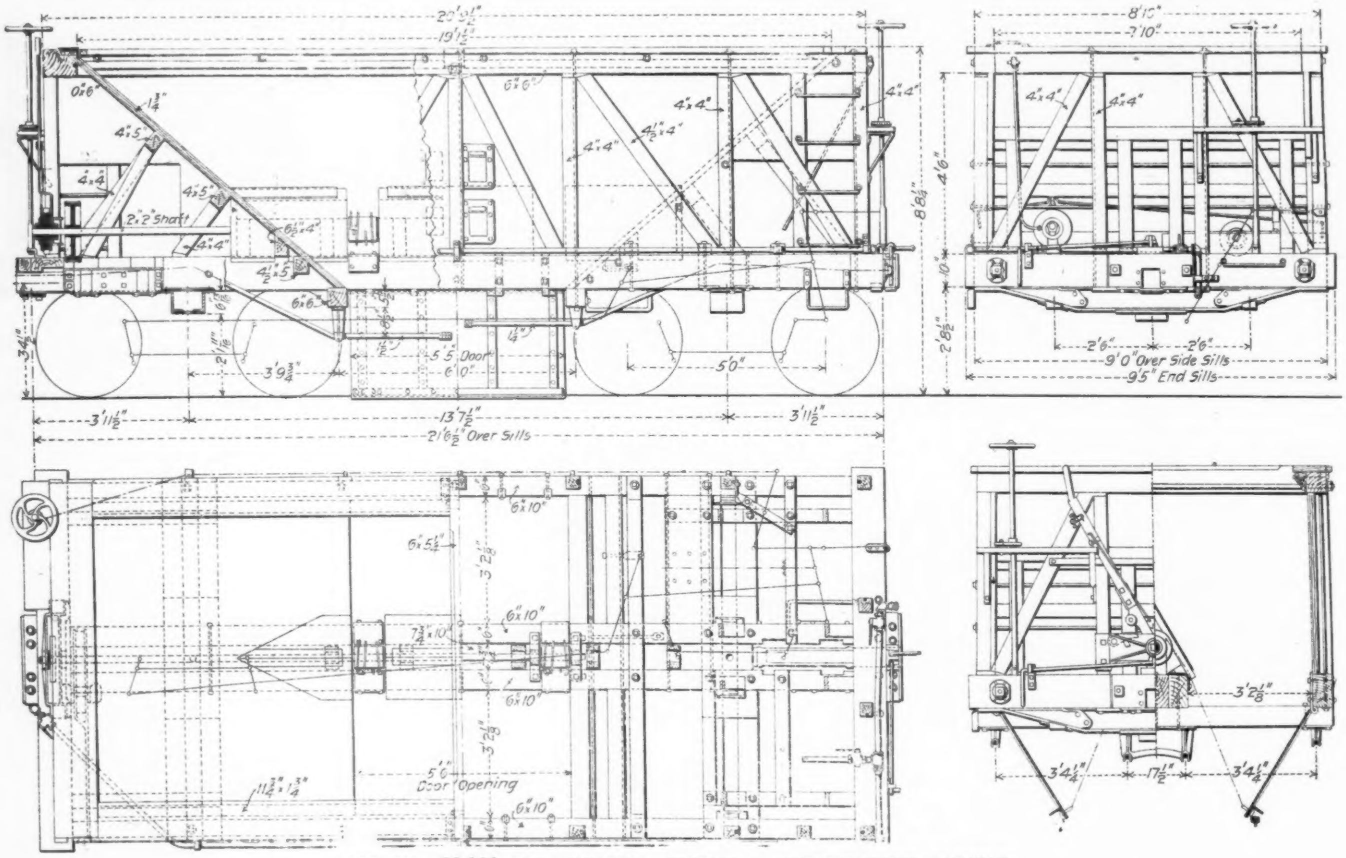
Since this criticism was prepared a paper on this subject has been read by Mr. W. R. Park before the New England Railroad Club, stating that recently fittings have been called for to provide for injectors delivering from 5,800 to 6,000 gals. per hour.

ORE CARS, 80,000 POUNDS CAPACITY.

CHICAGO & NORTHWESTERN RAILWAY.

These ore cars were designed by Mr. C. A. Schroyer, superintendent of the car department of the Chicago & Northwestern, to meet the special requirements of the large ore traffic of that road.

Their principal feature is in the very large door opening, 5 ft. 6 ins. long and 3 ft. 2 ins. wide, on each side of the car. The doors close against the lower faces of the sills and the hopper surfaces are at the ends only. When the doors are opened they drop against the rail heads and deposit the load



ORE CAR, 80,000 LBS. CAPACITY—CHICAGO & NORTHWESTERN RAILWAY.

to the ore pockets from between the rails. Unless the door openings are large the ore bridges over them and it is difficult to get the load out. To assist in guarding against this difficulty the car sides slope inwardly slightly toward the top. This bridging is particularly troublesome with high manganese ores, which cement together and are sticky. In this construction there is only about 20 ins. of obstruction at the center sills. Four "poke holes" are provided in each side for inserting bars to loosen the load when necessary. A shaft extends through the car at the center to operate the doors and it is turned by a lever and ratchet at the end.

The body bolsters are of Z bars. The draft gear is of the tandem spring type and is placed between the center sills where the draft is direct. The sills are four in number, 6 x 10 ins. in section and all of them trussed. In a car but 20 ft. long this construction presents a stiff backbone for pulling and buffing stresses. The officers of this road do not see any advantage in steel construction for cars of this length.

About 650 of these cars are now in service. After two years' service they weigh 28,000 lbs. and are carrying regularly from 50,000 to 100,000 lbs. of ore. They are mounted on Haskell & Barker trucks.

It has been erroneously reported that Mr. A. M. Waitt has resigned as superintendent of motive power and rolling stock of the New York Central & Hudson River Railroad. We are glad to state, upon the authority of Mr. Waitt, that he has not resigned.

The total heating surface of the nineteen boilers of the Norddeutscher Lloyds' twin screw steamship "Kaiser Wilhelm II." is 107,643 sq. ft, and the grate area 3,121 sq. ft. The boiler pressure will be 225 lbs. and the engineer will develop 40,000 indicated horse power.

In a recent issue of *The Autocar*, London, it was stated that if automobiles are ever to be anytning but toys for mad millionaires—which they are at present—the makers will have to devote their attention to the production of vehicles that will take the place of cabs and carriages, and that will not break down continually or cost a small fortune to keep in repair.

F. W. WEBB.

It is announced that Mr. F. W. Webb has asked to be allowed to retire from his activities as chief mechanical engineer of the London & North Western Railway, after 52 years of service. He entered the Crewe Works in 1851 and with the exception of a short interval has been there ever since, and during this time has built about 4,000 locomotives. He is in charge of 3,000 locomotives and in connection with his work has developed a large number of improvements invented by himself. Among other improvements, he is said to have been the first to use steel boiler shells. In 1878 he changed an old Trevithick engine into a compound and in 1882 built one to his own design. He has been a consistent advocate of compounding, and seven types of compounds of his design are now running on the London & North Western. His salary, according to *The Engineer*, from which these facts are taken, is $35,000 per year, that of his predecessor Mr. Ramsbottom, was $25,000 per year. This fact is commented upon elsewhere in this issue.

NEW LOCOMOTIVE SHOP.

READING, PA.

PHILADELPHIA & READING RAILWAY.

I.

GENERAL DESCRIPTION.

The new locomotive shops of this road at Reading, Pa., are the most extensive as to size of buildings in this country. Reading is the natural geographical center of the road, and of 1,500 miles of track no part is more than 150 miles from this point. The old shops were built in 1850, in James Milholland's time, and numerous additions have been made, resulting in the usual rambling plant cut up by streets, which was very inconvenient in handling material and work. It could have been put into shape to meet the needs of the next ten years, but instead of doing this a portion of a large tract of land north of the union station was utilized, where the possibilities of endwise extension are unlimited. The old shops will be abandoned. This new location is near the car shops and is favorable for a central power plant for driving both locomotive and car shops and furnishing all the lighting required by the company in Reading.

Capacity.—The shops were originally intended to repair 750 locomotives, but the entire equipment of the road, now numbering 1,000 locomotives, will be maintained here. At several outlying points small shops will be maintained for light repairs, such as are ordinarily made in roundhouses. It is intended to put all of the locomotives through the shops once in every eighteen months, which will require turning out 56 per month. This includes general repairs, boilers, tanks, foundry, pattern and smith shop work. The erecting shop has 70 pits and is intended to provide track room for 70 locomotives undergoing general repairs at one time. Of course the rapidity with which they will be turned out will depend upon the machine and other departments. The car shops are separate, but in the same tract of land and also on the west side of the main line. The land owned by the company in this section of the city is in a valley and lies on both sides of the main line. It is a long and relatively narrow tract. When in complete working order about 2,000 men will be required in the locomotive department, and there are already 800 men in the car repair shops.

The Ground Plan.—For such a large plant the arrangement is compact and the plan was worked out to group work of similar character together in order to reduce to a minimum the distance through which material and parts must be carried. It will be noted that there is no thoroughfare between the buildings from one side of the plant to the other and that the boiler shop joins the southwest corner of the erecting shop. The reason for this is that a thoroughfare could not be used at this point, as the west line of the shop buildings lies close to a 12-ft. wall at the top of which is the street. The buildings are not placed too close together for good natural lighting. They are very large and substantial in construction, built of brick of a handsome dark red color, upon a skeleton frame of steel.

The locomotive shop is arranged on the transverse track plan, with two outside bays, with 35 pits in each, each bay being 70 ft. in width, with the machine shop, 60 ft. in width, between them. To get locomotives into and out of the shop two 65-ft. turntables with concrete pits are employed at the northeast and southeast corners. This avoids the necessity of a transfer table and provides a safeguard against tying up the shop by the failure or breakdown of a single turntable. The locomotives, once in the shop, are handled by cranes, the crane service being excellent, and in fact a feature of the entire plant in all departments.

A glance at the ground plan shows the care which was taken to provide as far as possible for straight-line movements of material. An excellent example of this is seen in the location of the boiler shop, already referred to, which is such that the 35-ton cranes of the west bay of the erecting shop may run into the boiler shop, or, in other words, the 35-ton boiler-shop crane can be run into the erecting shop. It will be noticed that a track runs through the boiler shop, another one from the storage yard north of the locomotive shop through the center of the machine shop and storehouse and that all the large buildings are connected to the service tracks by turntables. The forge and smith shops have their east wall in line with that of the locomotive shop and the storehouse is placed between the boiler and forge shops, which is as convenient an arrangement as could be made. The foundry is further removed to the eastward of the forge shops and the carpenter and pattern shop are immediately north of the foundry. Extensions may be made to any or all of the buildings by building on to their ends.

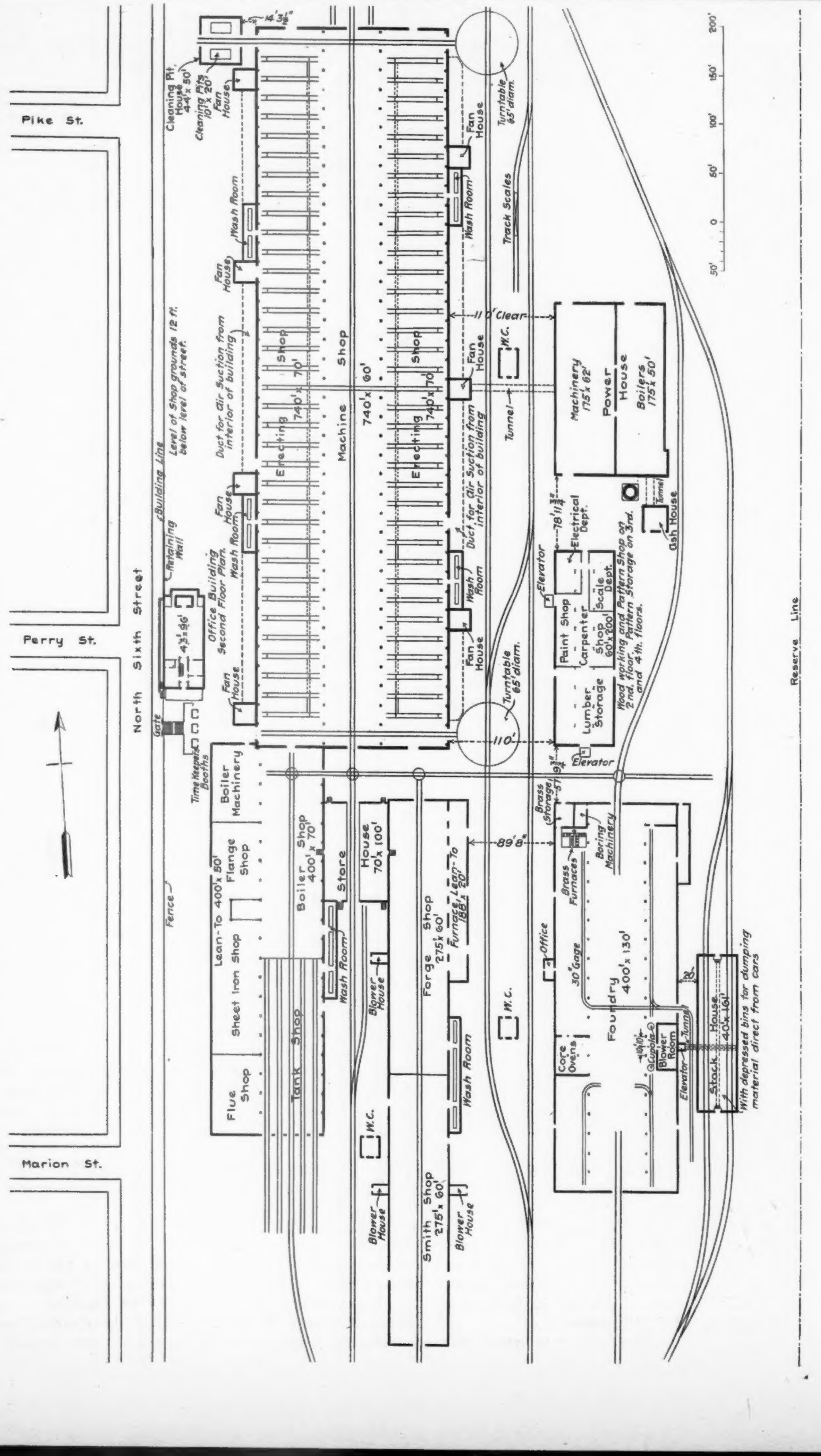
The power house location was important. In deciding upon its position the probable power consumption of the shops was carefully estimated, which revealed the fact that the center of the demand for power was close to the center of the locomotive shop. On account of the large quantity of power used in the locomotive building the power house was placed opposite its center. The cable and pipe tunnel leading from the power house enters the locomotive shop at its center and the crane, power and lighting mains are all fed at the middle of their length. This reduces the cost of feeders in this shop to one-fourth of that required by feeding at either end. At first it was intended to locate the power house at the south end of the shop yard, but this was abandoned for the reason stated. For distant transmission, as in the case of the yard lighting and the operation of the pumping plant at North Reading, 3,000 ft. away, where three motors are to be used for pumping purposes, the location of the power house did not matter so much as the transmission is by alternating current of sufficiently high voltage.

The main entrance for employees is through time-keepers' booths, with six gates, located at the south end of the office building at North Sixth street. Here the men are checked in and out. As the men enter the gates the time-keepers in the booths hand them numbered checks, which they retain while in the shop, returning them upon leaving. In this way the time of every man is taken from the length of time the check is out. The six gates easily accommodate 1,500 men, which is the number now employed at these works.

Locomotive Shop.—This building is the largest of its kind in this country. It is 750 ft. long by 200 ft. wide, with no divisions or partitions. The roof trusses of the erecting bays are 46 ft. 6 ins. from the floor and those of the machine shop are 33 ft. 5 ins. The crane service in this building is admirable, covering the entire floor area, including the machine shop, and it will be described in detail in a later issue.

One of the large 120-ton cranes, with its test load of 150 tons of steel rails, is shown in the large interior view of one of the erecting-shop bays. Each erecting-shop bay has one of these 120-ton Niles cranes with two 60-ton trolleys and an auxiliary 6,000-lb. hoist. These are the most powerful cranes ever put into railroad shops. On lower rails each of these shops has a 35-ton crane, and the boiler shop has one of this size also. The west side, therefore, has three cranes. Two 10-ton cranes serve the machine shop over its entire length.

By placing the heating fans outside of the building in seven lean-to fan-houses, locating the fan-ducts underground and locating the wash-room and accessories also in lean-tos, renders every square foot of floor area of this enormous building available for locomotives or machinery. At the northwest corner of the building is the cleaning pit in a building by itself, which is reached by the through track



NEW LOCOMOTIVE SHOPS, AT READING, PA.—PHILADELPHIA & READING RAILWAY.

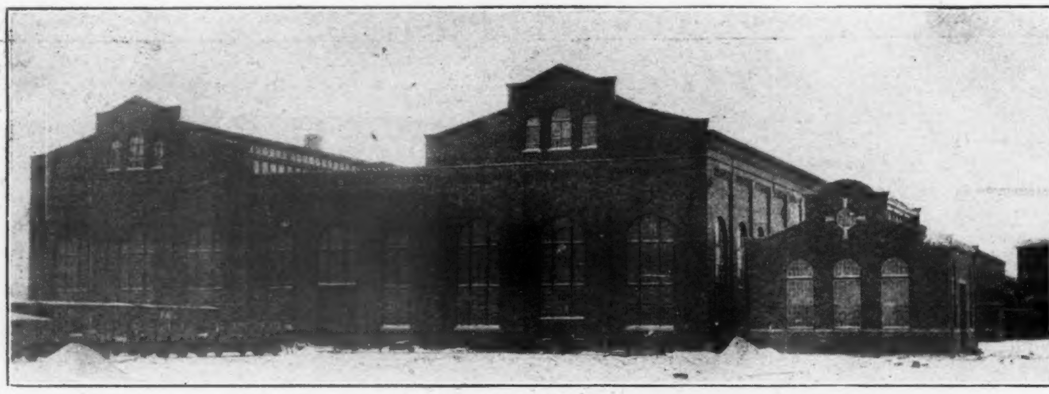
S. F. PRINCE, JR., *Superintendent Motive Power.*

WILSON BROTHERS & CO., Philadelphia, *Architects.*

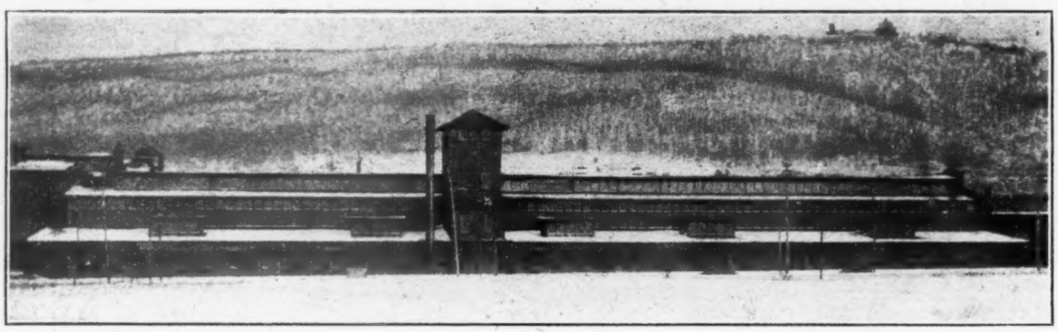
NEW LOCOMOTIVE SHOPS AT READING—PHILADELPHIA & READING RAILWAY

INTERIOR OF ONE OF THE ERECTING BAYS.

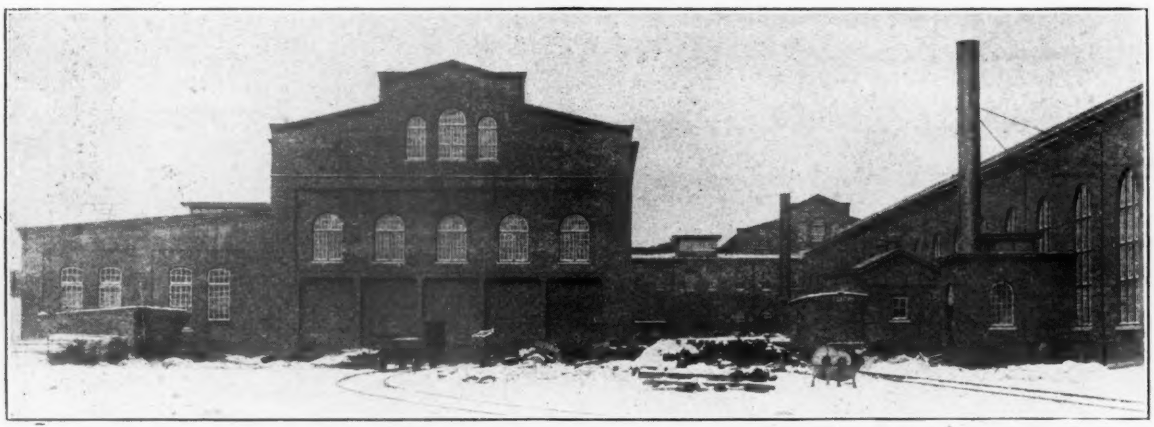
120-TON NILES ELECTRIC TRAVELING CRANE, WITH 150-TON TEST LOAD.



NORTH END OF LOCOMOTIVE SHOP, WITH MACHINE SHOP IN CENTER AND CLEANING-PIT HOUSE AT RIGHT.



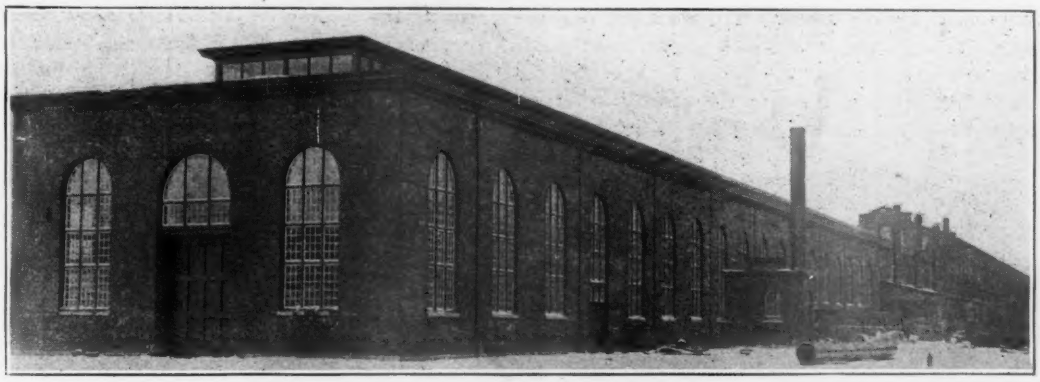
BOILER SHOP, FROM HIGH GROUND TO THE WEST. RIVETING TOWER AT THE CENTER. SHOWS THE LARGE AMOUNT OF GLASS IN ROOF.



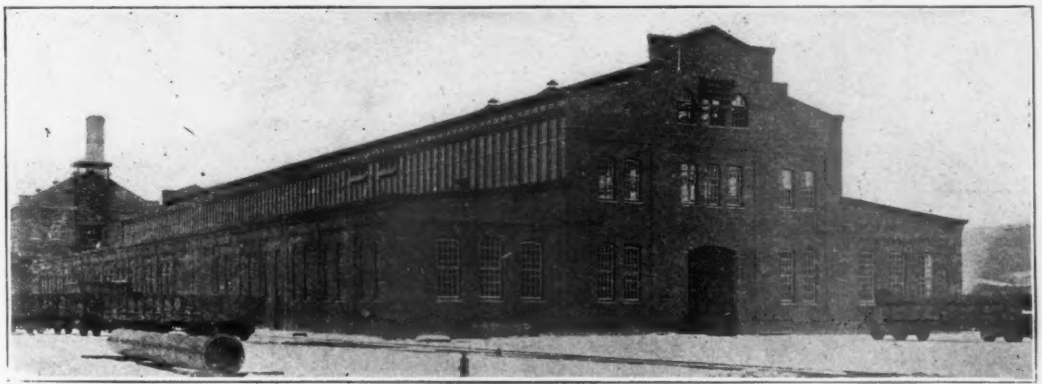
SOUTH END OF BOILER SHOP. FLUE DEPARTMENT LEAN-TO AT THE LEFT. ROLLING SHUTTER DOORS TO FIVE TANK REPAIR TRACKS. BLACKSMITH SHOP AT RIGHT. STOREHOUSE APPEARS AT THE REAR. ALSO SHOWS LAVATORIES AND FURNACE HOUSES AT THE RIGHT.

SIDE VIEW OF LOCOMOTIVE SHOP AND OFFICE BUILDING. MAIN ENTRANCE GATE AT THE RIGHT.

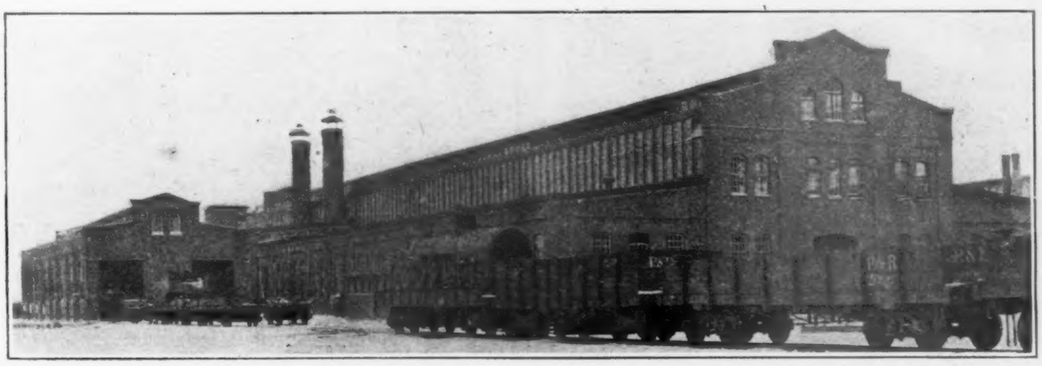
NEW LOCOMOTIVE SHOPS AT READING—PHILADELPHIA & READING RAILWAY.



SMITH AND FORGE SHOP BUILDING, FROM SOUTHWEST CORNER, SHOWING FURNACE LEAN-TOS AND WASHROOMS AT RIGHT.

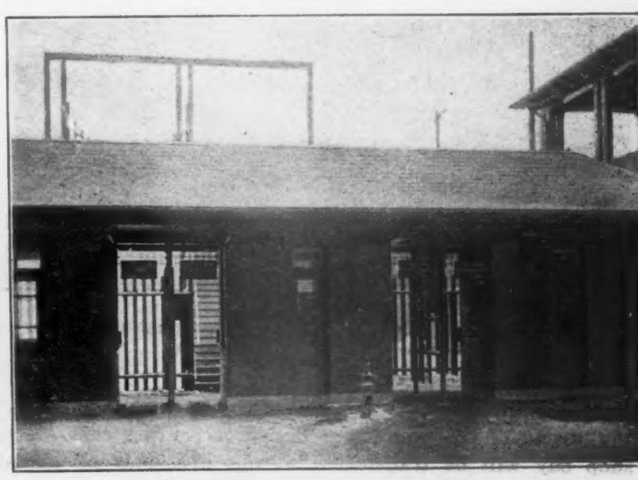


FOUNDRY FROM SOUTHWEST CORNER, SHOWING INSULATOR-RACKS AT GABLE WINDOW FOR OVERHEAD WIRE SYSTEM.



VIEW OF FOUNDRY FROM NORTHWEST CORNER, SHOWING CUPOLAS AND STOCKHOUSE AT LEFT.

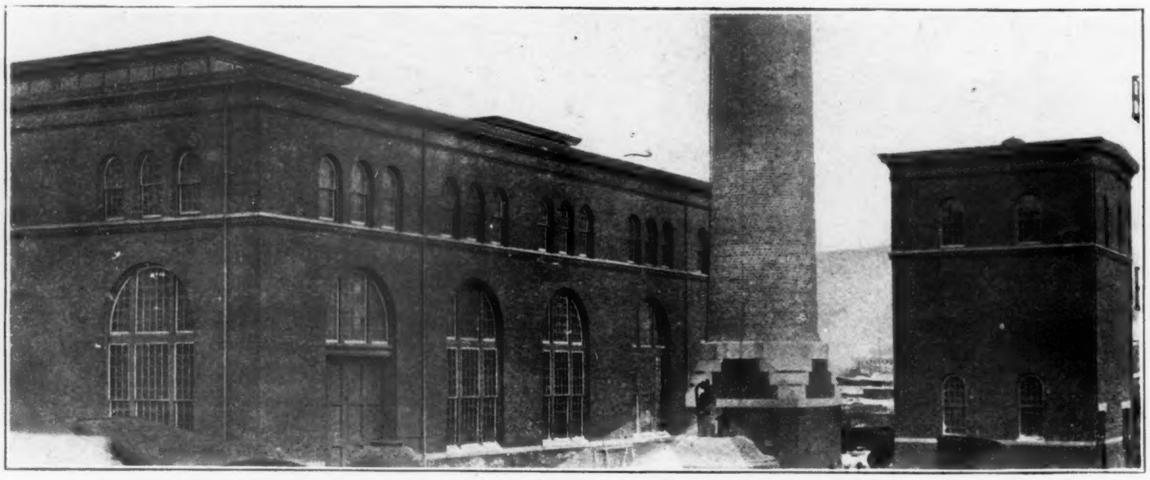
CARPENTER-SHOP BUILDING, SHOWING OUTSIDE STEEL CONSTRUCTION FOR ELEVATOR SERVING THE PATTERN LOFTS.



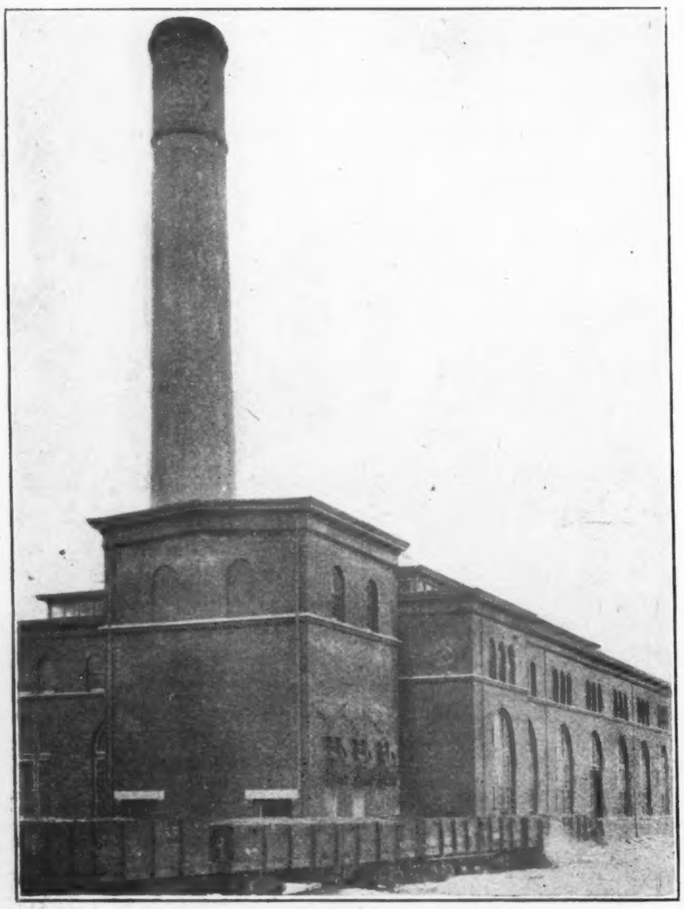
TIMEKEEPERS' BOOTHS AT MAIN ENTRANCE TO SHOP GROUNDS, FOR CHECKING THE EMPLOYEES IN AND OUT.

NEW LOCOMOTIVE SHOPS AT READING, PA.—PHILADELPHIA & READING RAILWAY.

across the north end of the shop. The locomotive-shop building is lighted by large windows and large areas of glass in the monitors on the roofs. A good idea of the natural lighting is presented in the large photograph already referred to. The arrangement of the main bay of the boiler shop in vice of the locomotive and boiler shop was first employed in the Concord shops of the Boston & Maine, illustrated in this journal in February, 1898. It will be noted that the arrangement of the two plants are very different, however, that of the Concord shops being with longitudinal tracks.



SOUTHWEST CORNER OF POWER-HOUSE, SHOWING STACK AND DUMPING ASH-TOWER AT RIGHT.



POWER-HOUSE FROM SOUTHEAST, SHOWING DUMPING CHUTES IN ASH-TOWER, AND COALING TRACK.

line with the west bay of the erecting shop is admirable for the west-side erecting bay. Boilers from the east erecting-shop bay will be transferred to the west side of the shop upon trucks and carried to the boiler shop by one of the cranes. It will be noticed that three tracks will be available for such movements, one at each end and one in the middle of the locomotive shop. This idea of continuous crane ser-

Proportions.—In studying the plans of these shops the following dimensions and proportions may be found interesting:

Floor Areas in Square Feet.

Erecting floors, 740 x 140	103,600
Machine shop, 740 x 60	44,400
Boiler shop, 400 x 120	48,000
Smith and forge, 568 x 60, 188 x 20	37,840
	233,840
Carpenter shop, 60 x 200 x 4	48,000
Power-house, 175 x 112	19,600
Foundry, 400 x 130	52,000
Storehouse, 100 x 70 x 2	14,000
Stockhouse, 161 x 40	6,440
Office building, 43 x 96 x 3	12,384
Cleaning pit, 44 x 50	2 200
	154,624
Locomotive shops proper	233,840
Accessory departments	154,624
Total floor area	388,464

Proportion of Area to Total Locomotive Shops Proper.

Erecting shop	103,600 sq. ft.	44%
Machine shop	44,400 sq. ft.	19%
Boiler shop	48,000 sq. ft.	21%
Smith and forge	37,840 sq. ft.	16%
	233,840 sq. ft.	100%

Relation to Erecting Floor.

Erecting floor	103,600 sq. ft.	100%
Machine shop	44,400 sq. ft.	43%
Boiler shop	48,000 sq. ft.	46%
Smith and forge	37,840 sq. ft.	36%

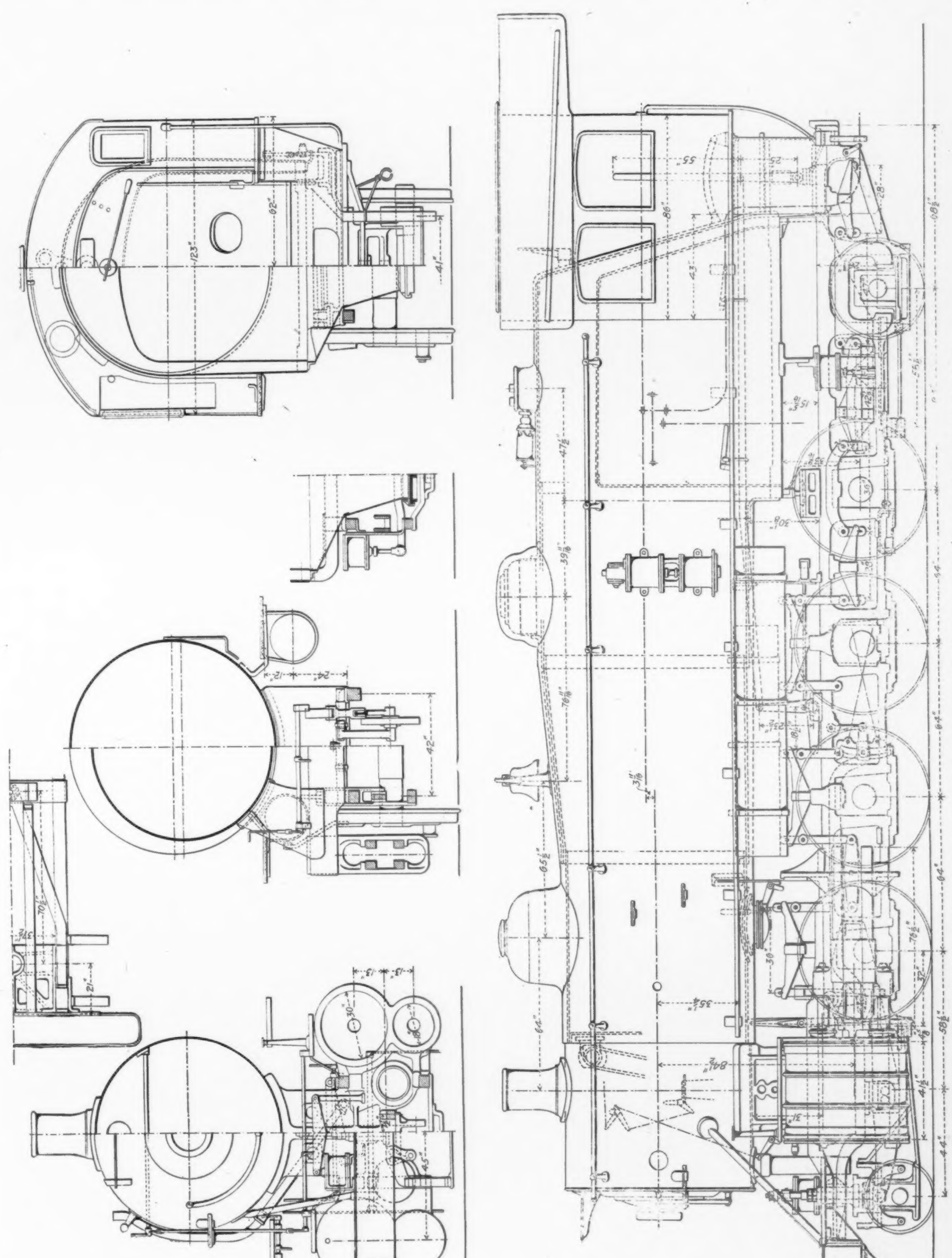
These proportions are interesting in comparison with the corresponding figures for the Collinwood shops of the Lake Shore & Michigan Southern Railway (American Engineer, October, 1902, page 304). These are summarized as follows in terms of the total area of locomotive shops proper:

	Collinwood.	Reading.
Erecting shop	22%	44%
Machine shop	33%	19%
Boiler shop	25%	21%
Blacksmith and forge	19%	16%

These figures will be misleading unless the descriptions of the two plants are carefully studied. With the erecting space considered as 100 per cent., the comparison is as follows:

	Collinwood.	Reading.
Erecting floor	100%	100%
Machine shop	147%	43%
Boiler shop	113%	46%
Smith and forge	84%	36%

In subsequent issues the construction of the buildings and the arrangement of their machinery and equipment will be presented in detail.



HEAVY COMPOUND FREIGHT LOCOMOTIVE.—ATCHISON, TOPEKA & SANTA FE RAILWAY.

2—8—2 TYPE.

G. R. HENDERSON, *Superintendent of Motive Power.*

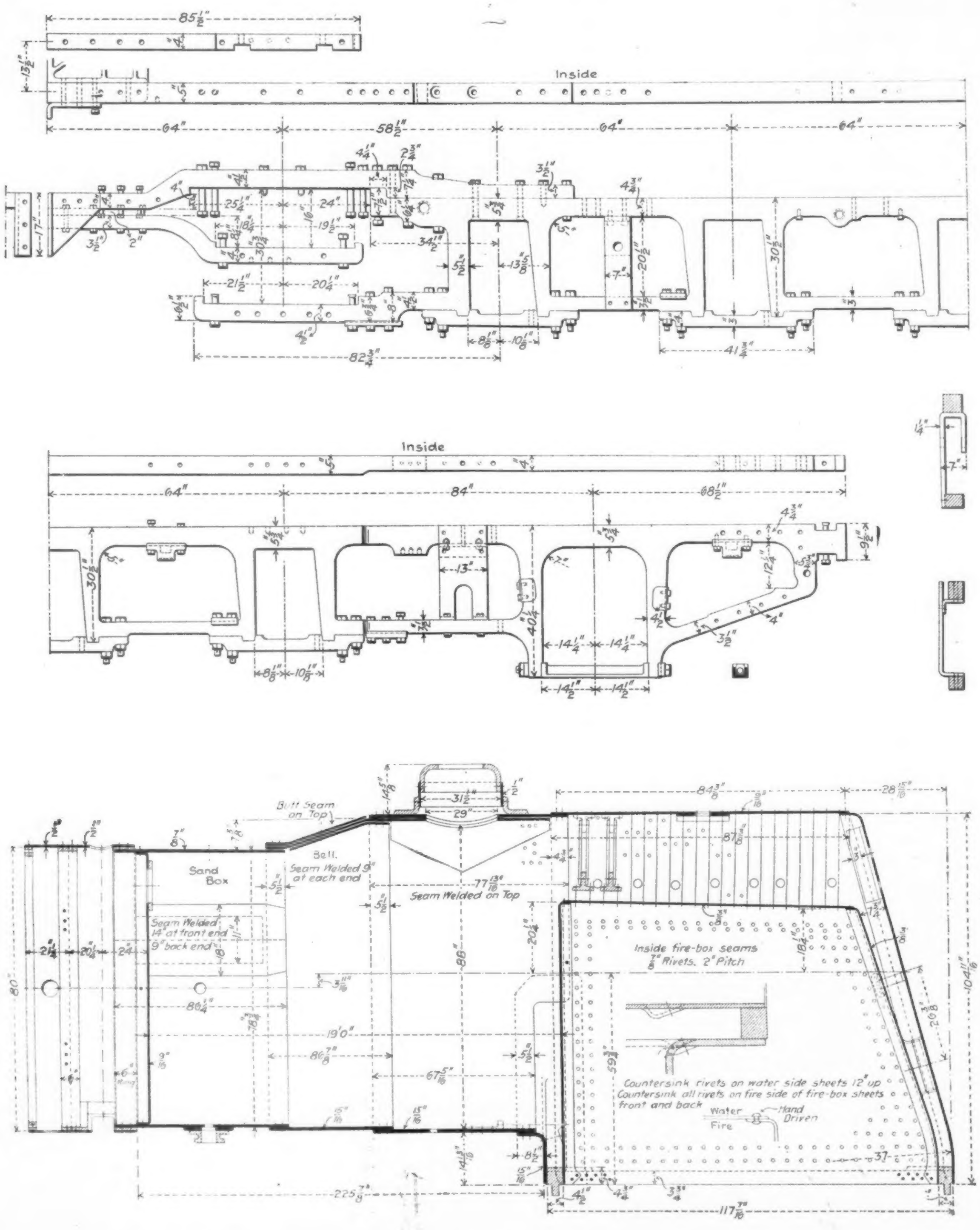
BALDWIN LOCOMOTIVE WORKS, *Builders.*

HEAVY COMPOUND FREIGHT LOCOMOTIVES.

2—8—2 (Mikado) Type.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

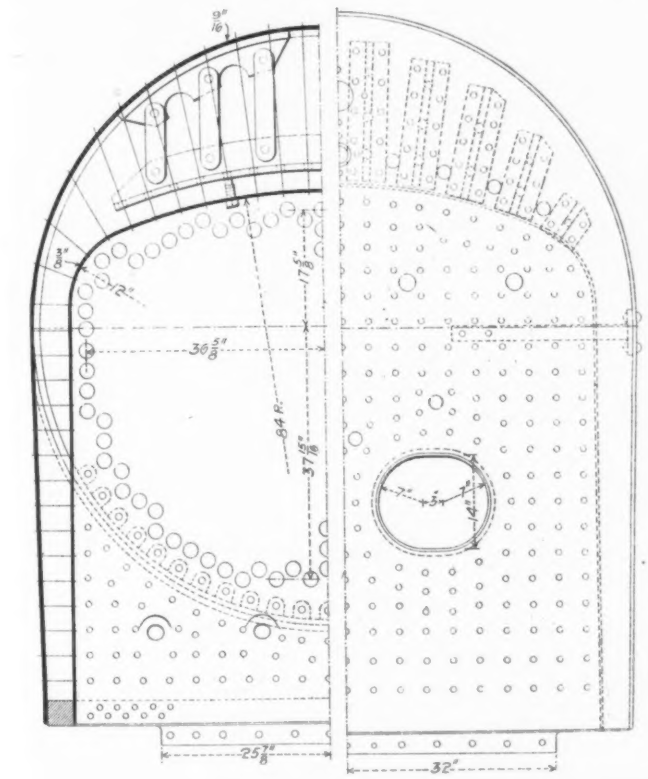
Fifteen of these heavy Vauclain compounds are now building at the Baldwin Locomotive Works. While considerably lighter than the design illustrated in the June number of this journal of last year, they are very heavy and powerful. A definite idea of their capacity is obtained from the tractive power (55,600 lbs.) and the heating surface (5,366 sq. ft.). In starting, using live steam in the low-pressure cylinder, they are equivalent to single-expansion locomotives with 24-in. cylinders. When running as compounds they are equivalent to single-expansion engines having 22.8-in. cylinders. The total weight is 260,000 lbs. and the weight on drivers (estimated) 200,000 lbs. In the matter of heating surface these engines have but 24 sq. ft. less than the largest area ever given to a locomotive, the 2—10—0 type of this road having 5,390 sq. ft. The boiler is practically the same as that illustrated in our June issue, both engines having 19-ft. tubes $2\frac{1}{4}$ ins. in diameter. The boiler pressure is 225 lbs. A photograph will be presented in a later issue and we hope to



BOILER AND FRAMES, HEAVY COMPOUND FREIGHT LOCOMOTIVE.—ATCHISON, TOPEKA & SANTA FE RAILWAY.

give an account of the work which these engines are doing. For convenience in comparison with other heavy engines the following ratios are presented:

$\frac{\text{Heating surface}}{\text{Volume of h. p. cylinders}}$	578
$\frac{\text{Tractive weight}}{\text{Heating surface}}$	37.3
$\frac{\text{Tractive weight}}{\text{Tractive effort (compound)}}$	3.59
$\frac{\text{Tractive effort}}{\text{Heating surface}}$	10.36
$\frac{\text{Heating surface}}{\text{Grate area}}$	91.7
$\frac{\text{Tractive effort} \times \text{diameter of drivers}}{\text{Heating surface}}$	590



THE FIREBOX.

These engines are equipped with the Player traction increaser, applied to the leading and trailing trucks, as indicated in the side-elevation drawing. This device was described on page 373 of our December number, 1901. The trailing truck is Mr. Kenneth Rushton's design (American Engineer, 1902, page 235). The leading truck has "three-point" hangers and spiral springs. The frames are 5 ins. wide and 5¾ ins. deep over the driving boxes. Like the 2—10—0 type already referred to, these engines have 11 x 12-in. main driving journals, the other driving journals being 10 x 12 ins.

Atchison, Topeka & Santa Fe Railway.
2—8—2 (Mikado) Type.
Freight Locomotives.

Road number 900
Gauge ....4 ft. 8½ ins.
Cylinder ....18 and 30 x 32 ins.
Valve ....Balanced piston
Boiler—Type ....Wagon top
  Diameter ....78¾ ins.
  Thickness of sheets....................⅞ and 15-16 ins.
  Working pressure ....225 lbs.
  Fuel ....Coal
  Staying ....Radial
Height of center above rails....................9 ft. 6½ ins.
Firebox—Material ....Steel
  Length....................108 ins.
  Width ....78 ins.
  Depth ....Front, 80 ins.; back, 78 ins.
  Thickness of sheets
    Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube, 9-16 in.
  Water space....................Front, 4½ ins.; sides, 4 ins.; back, 4 ins.
Tubes—Material ....Iron
  Wire gauge ....No. 11
  Number 463
  Diameter ....2¼ ins.
  Length ....19 ft.
Heating surface—Firebox ....210.3 sq. ft.
  Tubes ....5,155.8 sq. ft.
  Total ....5,366.1 sq. ft.
  Grate area ....58.5 sq. ft.
Driving wheels—Diameter outside ....57 ins.
  Diameter of center ....50 ins.
  Journals ....Main, 11 x 12 ins.; others, 10 x 12 ins.
Engine truck wheels (front), diameter ....29¼ ins.
  Journals ....6½ x 10½ ins.
Trailing wheels, diameter ....40 ins.
  Journals ....76 x 12 ins.
Wheel base, driving ....16 ft.
  Rigid ....16 ft.
  Total engine ....3 ft. 6½ ins.
  Total engine and tender ....62 ft.
Weight on driving wheels (est.)....................200,000 lbs.
  Total engine (est.) ....260,000 lbs.
  Total engine and tender (est.) ....400,000 lbs
Tank, capacity ....7,000 gals. and 12 tons.
Tender ....Number of wheels, 8; diameter, 34¼ ins.
  Journals ....5½ x 10 ins.

COST OF OPERATING TURNTABLES BY POWER.

A comparative statement of costs of various methods of operating turntables by power, prepared for the Association of Railway Superintendents of Bridges and Buildings by Mr. F. E. Schall, bridge engineer of the Lehigh Valley Railroad, presents interesting figures. He states that equipments for driving turntables by gasoline engines cost about $1,100 and by electric motor (General Electric Company) about $1,150, and that the economy depends upon the number of engines turned, as the following record shows:

[Note.—These figures do not include interest or depreciation, which would amount to about 45 cents per day.]

64-Ft. Turn-Table at Coxton, Pa., 5 H. P. Gasoline Engine, Installed July, 1901.

Average number of engines turned per day of 24 hours in a period of one year, 174.
Average cost per engine turned in a period of one year, 2 21-100 cents.
Average cost of labor and material operating turn-table per day of 24 hours, $3.78.

75-Ft. Diameter Turn-Table at Lehighton, Pa., Operated by 5 H. P. Gasoline Engine, Installed February 12, 1902.

Average number of engines turned per day of 24 hours, 121.
Average cost per engine turned, 2 9-10 cents.
Average cost of labor and material operating turn-table per day of 24 hours, $3.41.

75-Ft. Diameter Turn-Table at South Easton, Pa., Operated by 5 H. P. Gasoline Engine, Installed March 14, 1902.

Average number of engines turned per day of 24 hours, 188.
Average cost per engine turned, 1 97-100 cents.
Average cost of labor and material operating turn-table per day of 24 hours, $3.74.

75-Ft. Diameter Turn-Table at Wilkesbarre, Pa., Operated by 5 H. P. Gasoline Engine, Installed March 18, 1902.

Average number of engines turned per day of 24 hours, 46.
Average cost per engine turned, 6 5-10 cents.
Average cost of labor and material operating turn-table per day of 24 hours, $2.91.

75-Ft. Diameter Turn-Table at East Buffalo, N. Y., Operated by 5 H. P. Gasoline Engine, Installed April 1, 1902.

Average number of engines turned per day of 24 hours, 103.
Average cost per engine turned, 3 37-100 cents.
Average cost of labor and material operating turn-table per day of 24 hours, $3.41.

64-Ft. Turn-Table at Sayre, Pa., Operated by 20 H. P. Electric Motor, Installed June 1, 1902.

Average number of engines turned per day of 24 hours, 109.
Average cost per engine turned, 3 7-10 cents.
Average cost of labor and material operating turn-table per day of 24 hours, $4.01.

Mr. Willard A. Smith, for many years publisher of the *Railway and Engineering Review*, has bought the *Age of Steel* and consolidated it with his other recent purchase, *Iron and Steel*. They will be published under the name of *The Iron and Machinery World*, with Mr. Smith as president and Mr. Bruce V. Crandall (who is associated with him) as secretary and treasurer. Under the management of these gentlemen the new publication is sure to build upon the records of the merging journals and reach a higher plane of success than either has attained alone.

THIRTY-TON BOX CAR WITH STEEL UNDERFRAME.

AMERICAN RAILWAY ASSOCIATION DIMENSIONS.

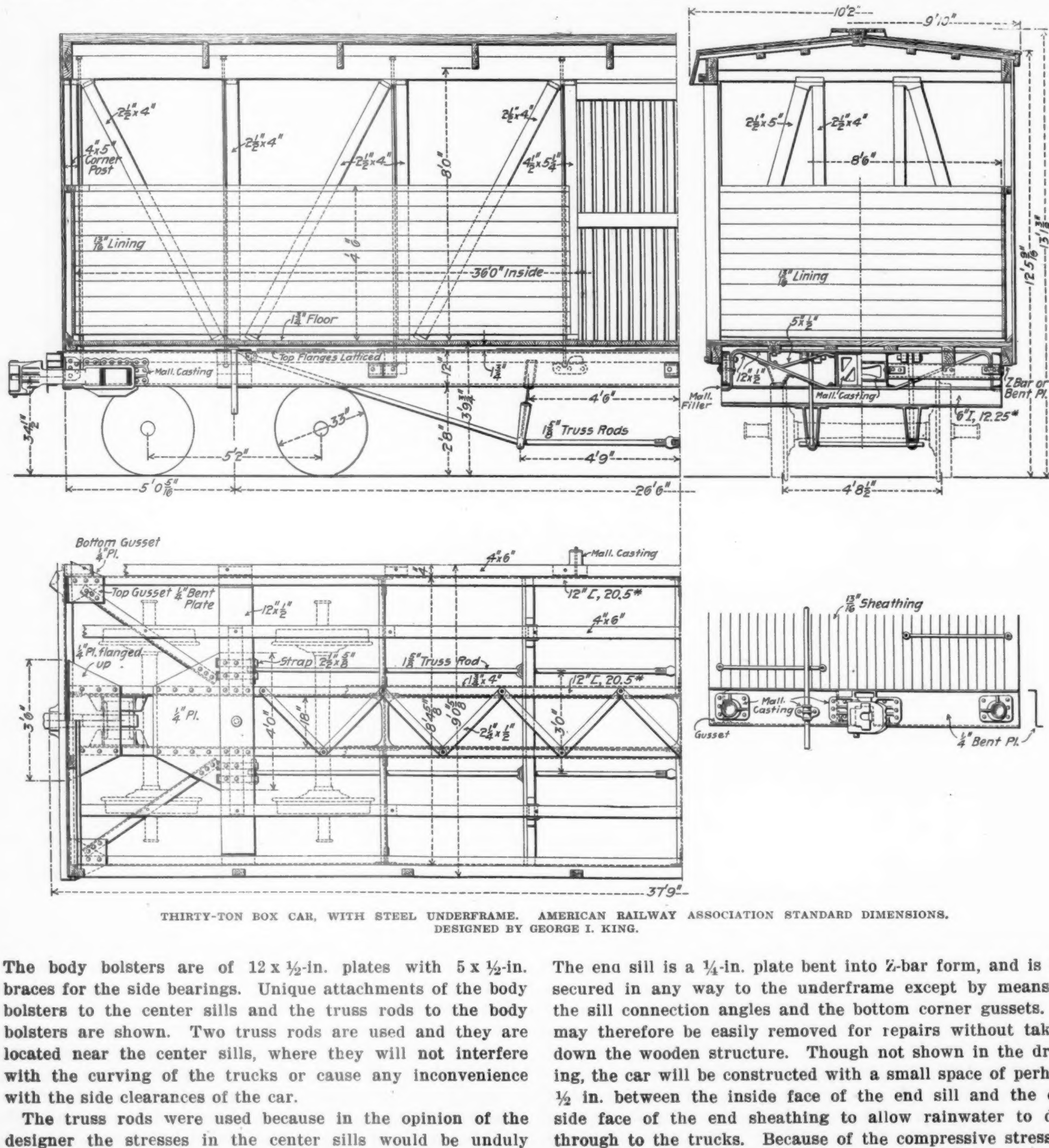
DESIGNED BY GEORGE I. KING.

This car was designed at the Middletown Car Works by Mr. George I. King in order to meet the demand for a structural underframe of ample strength but of such simple type that it may not only be built new in any ordinary railroad shop, but that it may be repaired with equal facility.

The four longitudinal sills are 12-in. channels, the center sills being trussed with 1⅝-in. rods between the bolsters. The body bolsters are of 12 x ½-in. plates with 5 x ½-in. braces for the side bearings. Unique attachments of the body bolsters to the center sills and the truss rods to the body bolsters are shown. Two truss rods are used and they are located near the center sills, where they will not interfere with the curving of the trucks or cause any inconvenience with the side clearances of the car.

The truss rods were used because in the opinion of the designer the stresses in the center sills would be unduly great in a combination of severe buffing shocks or locomotive jerks with the direct stresses arising from the load in the car. It was considered wise to support the sills with these rods. For nearly vertical stresses channels lighter than 12 ins. could have been used, but for the combination stresses and the severe buffing stresses it was considered desirable to neglect a small possible saving in weight in favor of strength. The suggestion of trussing a steel underframe seems a little out of the ordinary at this time. There is no doubt, however, that this is a cheaper and lighter construction than one of equal strength made of rolled sections without the trussing, and with larger sills it would be difficult to secure the standard inside height. With this construction the height over the trucks is practically the same as it would be with pressed steel sills of the fish-bellied form.

Attention is directed to the gussets at the ends of the sills, which are flanged up to form shoulders for the subsills, to secure the end frame from being pushed out by the load. The end sill is a ¼-in. plate bent into Z-bar form, and is not secured in any way to the underframe except by means of the sill connection angles and the bottom corner gussets. It may therefore be easily removed for repairs without taking down the wooden structure. Though not shown in the drawing, the car will be constructed with a small space of perhaps ½ in. between the inside face of the end sill and the outside face of the end sheathing to allow rainwater to drip through to the trucks. Because of the compressive stress in the center sills, due to the tension in the truss rods, the center sills are latticed together on top. The drawing also shows side sill brackets made of Z bars to support the side nailing strips. One of these is placed under each post and the brackets take the nuts for the side-frame truss rods.



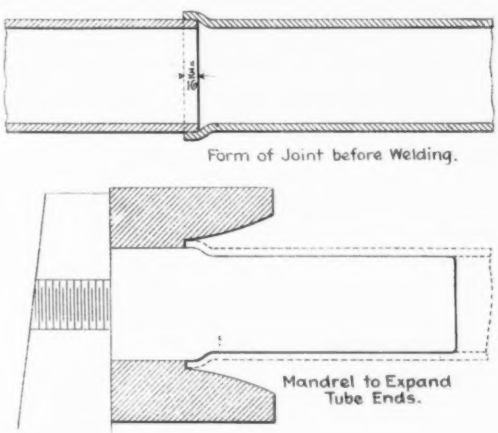
THIRTY-TON BOX CAR, WITH STEEL UNDERFRAME. AMERICAN RAILWAY ASSOCIATION STANDARD DIMENSIONS. DESIGNED BY GEORGE I. KING.

This form of bracket secures the nailing strips from side motion independent of the bolt connections. In the plan view the corner bracing and the plates over the center sills at the bolsters are worthy of special attention.

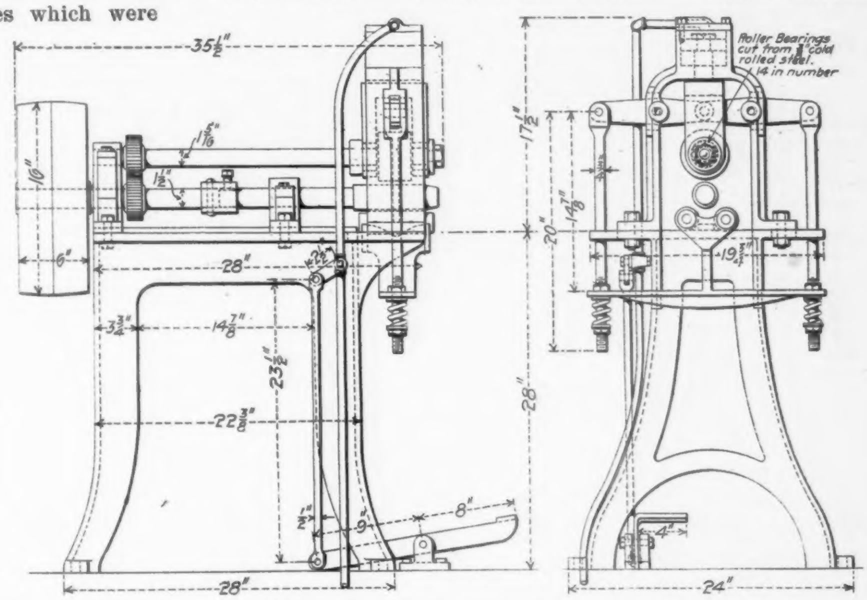
The designer sought to produce a structural underframe which with slight modifications would be applicable to flat, gondola, stock and box cars. It is an interesting construction and it is hoped that our readers will criticise it freely.

NOVO STEEL.

In the new era of improvements in shop methods the central and essentially vital elements are new tool steels and electric driving of machine tools. These go hand in hand, and it may be said that improved steels make motor driving necessary and that together these factors of the present situation will revolutionize not only shops methods but design, construction and speeds of driving of machine tools. As in the case of the projectile and armor plate, the projectile in this case—that is, the steel—is at present far ahead of the armor plate, represented by the machine. The new steels make new machines chatter with the heavy cuts which are now made possible. The machines must be made stronger and more rigid. The rules of the past few years in regard to motor capacity required for various machines, fail, and the motors are stalled by these cuts. The motors used must be more powerful than required by the rules which were sufficient only a year or so ago. The recently developed methods of hardening steel make it necessary to begin anew in these three important directions: To increase cutting speeds, provide geater strength and rigidity in machines and supply greater power to drive them.



SKETCH OF THE MANDREL DEVICE.



FERGUSSON'S PNEUMATIC FLUE WELDING MACHINE.

Blue chips are now found at the large machines in every shop pretending to be at all up to date, and in a tour of many shops recently made by a representative of this journal, "Novo" steel (Hermann Boker & Co., 101 Duane street, New York) was frequently found and as frequently praised by those who are using it. The remarks in the first paragraph on page 378 of our December number referred to this steel, and attempts will be made to secure more reliable data with regard to it. That paragraph has brought a large amount of correspondence indicating the vital interest which is taken in the subject. Additional reports of this steel indicate the possibility of speeds of 91 ft. per minute in boring Midvale tires with ⅛-in. cuts and ⅛-in. feeds. Axles are reported to have been turned at a rate of 45 ft. per minute with ⅜-in. cuts and ⅛-in. feeds. The most remarkable fact about this steel is that it may be annealed so that it machines and handles in the shop as readily as soft annealed tool steel.

Further reports are at hand of 1 1-32-in. Novo steel drills running at 128 revolutions per minute and drilling 596 holes ⅝ in. deep in hard steel castings, without regrinding. Numerous other records are available and these will receive attention in these columns.

In presenting his paper upon the requirements of machine tool operation, recently read before the New York Electrical Society, Mr. Charles Day, of the engineering firm of Dodge & Day, placed Novo steel as equal if not superior to the well-known Taylor White steel.

PNEUMATIC FLUE WELDING MACHINE.

This interesting machine was developed and patented by Mr. H. A. Fergusson, assistant superintendent of motive power of the Chicago Great Western, and is in use at the Oelwein shops of that road, where it is attracting a great deal of attention because of its remarkable work.

The rotating spindle and the large roller are belt-driven, the mechanism being clearly shown in the engraving. When the tube with the safe end upon it is in position for welding, the foot lever is pressed and the upper roller, which is on a roller bearing, is forced downward with a pressure of about 1,200 lbs., by means of the air cylinder; the levers, acting through the spiral springs, raise the lower and longer rollers up against the under side of the tube at the same time. This makes so perfect a weld that the joint cannot be found when cool. A weld is completed in four or five seconds. Instead of scarfing the safe ends, they are simply cut off square, and the tubes heateu and driven into a die over a mandrel which enlarges the ends enough to pass over the safe ends with a parallel fit 3-16 in. long. A very short fit is sufficient. The writer was shown a piece of tube 4 ft. long made up with 11 welds and none were evident upon the surface.

To return the upper roller to its normal position after the air is exhausted, a spring is placed under the piston in the cylinder. The spiral springs shown in the end view are to adjust the pressure of the bottom rolls. This machine makes a cylindrical weld. Since March 25, 1902, the tubes of 53 engines and enough more to make a total of 25,000 tubes have been welded on this machine with a saving in tube material sufficient to retube one entire engine. The welds from this machine do not leak and they are not even tested before being placed in the boilers.

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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CONTENTS.

Owing to the unusual demand for space in this number the record of the American Engineer Tests must be interrupted for one issue. We can now state that the results are satisfactory and that very valuable relationships of the front end factors have been established.

There is one advantage that results from the use of the electric motor for driving machine tools which is almost entirely overlooked, namely the facility with which it may be ascertained whether a particular machine thus driven is operating at its highest efficiency. This may, with suitable current measuring instruments, be accomplished by comparing the power consumed by the motor in driving it with the power required for driving another similar machine. In the case of a number of machine tools individually driven by motors, if it is suspected that one machine is using too much power, a brake test of the motors or an exchange of motors will quickly show the truth of the matter, and may suggest an easing up of bearings in different places or other changes to get rid of waste of power.

In connection with the reported retirement of Mr. F. W. Webb from the position of chief mechanical engineer of the London & North Western Railway it is stated that his salary is $35,000 per year, while that of his predecessor, Mr. Ramsbottom, many years ago, was $25,000 per year. In view of the fact that the United States, rather than England, is noted as a country of high salaries, this fact is noteworthy and important. It seems appropriate to ask why our motive power superintendents receive such miserably small compensation for the work which they do. Can it be possible that we do not have men in this country worth $35,000 a year, and that it does not pay to give such a salary to a $5,000 or a $6,000 man? If there is a position connected with any mechanical pursuit which calls for greater ability, knowledge, experience and business capacity than that required to properly manage the motive power interests of a large American railroad, we do not know where to find it. It is a fact that many of the best motive power officers have been attracted to other lines of industry and it is now exceedingly difficult to find men who can do what railroad owners want to have done. These men are sought by manufacturing concerns because their peculiar qualifications are required in the management of large industrial enterprises. It is practically impossible for men in other pursuits to apply their experience to railroads; consequently the railroads are losing and not gaining good men. They must necessarily train their own officers and if they expect to properly meet the problems of the future they must attend to the salaries at once, but this is not all. The time has arrived when a man who is merely a good mechanic, organizer and executive cannot fill the bill. He must be also a good business man. To attract and keep such men in the service, the gates to the higher operating positions must be thrown wide open to furnish an outlet for their talents. When both of these things are done, and not until then, can the ranks of motive power officials be properly recruited.

ELECTRICAL EQUIPMENT AT COLLINWOOD SHOP.

In this issue we present another descriptive article relating to the interesting Collinwood shops of the Lake Shore & Michigan Southern Railway, taking up this time the details of the electrical equipment for the lighting and the power for machine tools, cranes and turntables. Never before in the history of railroad development has such a complete electrical equipment been installed exclusively for service in a railroad shop installation. The advantages of electricity seem to have been secured—the lighting system is most complete and flexible, while the motor drives for the machine tools have not only made the tools independent, accessible and

economical, but also has very greatly reduced the floor space required for the large number of tools installed. The result has been a most complete utilization of the large floor space, with absolutely no sacrifice of accessibility or convenience.

It has been thought by some that space on a shop floor is by far too valuable to be utilized for lavatories and lockers, as was done in the Collinwood shops; however, at the present the space occupied by them is not needed, but if it should be as a result of unforseen growth, the task of removing them to a position outside the building in order to render available the space now occupied could not be very difficult and, viewed in this light, their location appears to be the result of unprecedented forethought by the officials who laid out the plans for the shop buildings.

MACHINE TOOL PROGRESS—FEEDS AND DRIVES.

The growing use of constant-speed motors, as gas and oil engines or synchronous alternating-current electric motors, for example, has rendered the utilization of mechanical methods for obtaining variable speeds an absolute necessity in industrial applications, and the use of mechanical devices for this purpose has become so important as to render valuable a thorough investigation of the various types and modified forms of such devices with reference to their mechanical and to their commercial merits. True variable-speed methods have long been in existence in the form of the cone pulleys and belt arrangement, the lathe back-gear, and the screw-cutting changegear attachment, all of which have been identified with machine tools since the earliest days of engine lathe practice; but modern machine tool and industrial machinery practice have tended towards, and have come to demand, methods by which these changes of speed may be effected, with no interference to the transmission of power, as well as also with a much greater number of variations of speed within the speed range. This is particularly true of all modern machine tool practice identified with economic production and it is today the greatest desideratum in automobile and motor-car practice where constant-speed gas engines are so much used.

The article under the above title, of which the first of a series is begun on page 27 of this issue, is the result of an extended investigation of the subject made by our Associate Editor, Mr. C. W. Obert, prior to his connection with this journal. The subject is treated from an entirely practical standpoint with reference more to the service of the apparatus to the user than to the question of design. We hope that the results as set forth will do much to show what is necessary for the greatly needed increase of productivity of machine tools in railroad shops by indicating the direction toward which progress is tending in machine tool practice.

PIECEWORK AND THE WORKER.

"How to change the worker's attitude toward his work by means of a change in the system of apportioning the recompense for it would seem to be the foremost problem of the opening years of the new century."

This is the foundation of one of the best arguments for piece-work that has appeared. It is quoted from a paper entitled "Gift Propositions for Paying Workmen," read last month by Mr. Frank Richards before the American Society of Mechanical Engineers. The paper should be read by every employer of men. No attempt is made to present it in abstract here and space does not permit it to be printed in full.

The author discusses the modifications of the piece-work system known as the premium plan and the bonus system, taking issue with them on the ground that both give to the employer more than a proper share of the extra profits due to increased output through additional efforts on the part of workmen above what may be fairly expected of them for a day's work. Concrete examples are presented in detail to show that under these systems if a workman increases his product by one-half, and if for the extra half output he is paid at one-half the piece price, which would be determined by his day rate, the employer makes half the wages which would be paid to another workman, working under the old rate of production per man. This profit serves to reduce the cost per piece of the work done and makes the plan popular among manufacturers. Mr. Richards argues that the essential error in both of the systems referred to is in ignoring the strictly business relation of employer and employee. He asks: Why should the employer not pay in exact proportion to the quantity of work done?

The premium and bonus systems, and also straight piecework, have for their object the same thing, namely, increased output and reduced cost. They all aim to induce men by rewards to put forth their utmost endeavors. They differ, however, in one essential detail—in the character of the reward. Straight piece-work offers the whole reward to the workmen, while the other systems divide it more or less equally between the employer and the workmen. This division is made in order to lessen the temptation of the employer to cut the rates of the men, and it is an effort to secure the maximum effort of the men through the offer of the least possible inducement to secure that effort, and one which will prevent the earnings of the men from becoming uncomfortably large.

In other words, the premium and bonus systems offer an easy method of establishing prices and of correcting the effect of prices which are too high without actually cutting the rates—and rate-cutting is the rock on which piece-work is often wrecked. Mr. Richards says: "It is my view that for everything a workman can do there is a fair and equitable price, whatever the difficulty of determining that price, and that when a man does the work he should get the price." This seems to be pure and simple Honesty.

We cannot see wherein piece-work in any way fails to meet the need. Any plan which does not require dollars to be paid for pieces produced is sleight-of-hand and the men get the worst of it. The great and only trouble with piecework seems to be the desire to cut the prices after they are once settled and the men get to making a little money. It is one thing to install piece-work in a shop and quite another thing to install it properly. The first requisite is to educate the men to have absolute confidence in their employer and to believe that at all times the employer will be fair to them. They should be made to feel that they are as much interested as the employer in getting the prices right. Where this plan is pursued piece-work prices are not put into effect by the hundreds, but gradually. Where it is done in this way it is successful and prices that are right do not need to be cut or changed until some new element or process comes up for consideration and calls for a new price because of a change in the conditions.

Again quoting from Mr. Richards: "The essential justice of the piece-work system remains, and it might be well worth while to investigate the mistakes, and worse, which have misdirected its application." In other words, piecework should be tried fairly before substituting anything else for it.

Few of our readers are experienced with the premium system, but many of them are using the piece-work plan. Because this paper directs attention so forcibly to the importance of correct prices, it is important. Intelligent price fixing requires the attention of specialists and it behooves every establishment having the piece-work system or about to take it up to develop men who will understand and can develop the system properly.

NEW LOCOMOTIVE AND CAR SHOPS.

COLLINWOOD, OHIO.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

IV.

THE ELECTRICAL EQUIPMENT.

The application of an electrical system of distribution of power for the entire locomotive and car repair shops at Collinwood has rendered necessary a very complete and thoroughly equipped distribution system, which is necessarily of considerable magnitude inasmuch as all the lighting for the shops and yards and all the power for tool and crane driving in the shops, with the exception of a small percentage of compressed-air driven portable drills, hammers, etc., and the hydraulic riveter, are supplied electrically. All the motors and also the lamps, both arc and incandescent, are supplied by current from the same bus-bars in the central power plant, which was fully described on pages 332—339 of the November, 1902, issue of this journal. The distances from the power house to the various points of current consumption are not great, the only point to which current had to be transmitted outside of the shops themselves and the adjacent yard lighting being the roundhouse, which is lighted electrically and uses electric power for the turntable, so that the maximum distance of transmission is about 3,000 ft.; this distance renders the voltage of 240 volts sufficiently economical and it was preferable that no higher voltage be used for the sake of safety.

THE LIGHTING SYSTEM.

The electric lighting system for the shop buildings and yards comprises both arc and incandescent lighting, all lamps being fed from the same mains and at the same voltage, the dynamo voltage of 240 volts.

For the arc lighting enclosed arc lamps are used, operated at 120 volts each by connecting in groups of two in series across the 240-volt mains. Enclosed arcs are used not only for their high economy in the consumption of carbons and current but also on account of their nearly perfect diffusion of light, and the 120-volt lamp was used in preference to the lamp arranged for 240 volts on account of the better quality of light obtained from the lower voltage arc. In the erecting shop the arc lamps are distributed one at each space between pits, hung alternately at opposite ends; *i. e.*, in one space at the south side of the shop and in the next space at the machine-shop side. This same arrangement of arc lamps is carried out in the boiler shop, while in the machine shop arcs are hung in every other bay on the girder in the middle between the heavy tool and light tool sections. The arc lamps were supplied by the Fort Wayne Electric Works, Fort Wayne, Ind., under a guarantee as to performance, each lamp being provided with an automatic attachment which will keep it burning if its mate in the series burns out.

An incandescent lamp is provided at every machine tool, being supported on a swinging bracket fastened to the tool and usually fed by a flexible double-conductor insulated cord hanging slack from mains on the roof-trusses above. The lamps on the direct motor-driven tools are, however, fed with current from the power circuit for the motor on that tool. The incandescent lamps used are all the special long-filament 240-volt lamps, connected singly across the mains. Between the pits in the erecting shop there are lamp-posts erected, one in the center of each bench, with four swinging brackets at their tops and a four-light cluster just below, at about 7 ft. above the floor; extension-cord plugs may be inserted in any socket of the brackets or of the cluster for portable lamps in any location desired; also, 25-ampere capacity extension-plug receptacles are provided at every post, so that flexible cords may be run for 5 horse-power portable motors at any point desired, feeding from the lighting mains, and extra receptacles from which to run extension-cord portable lamps are placed at every post in the shop.

The feeders for the lighting system are run from their respective main switches on the feeder panels of the switchboard in the power-house under ground, through basement and then the piping tunnel, to the southeast corner of the locomotive shop, and enter two distribution boxes. From these, feeders run on the wall of the building at a height of 16 ft. above the floor to distributing panel boards placed at convenient locations from which to lead the mains separately to the lights fed.

From the panel boards the arc and incandescent light circuits are run separately. There are a few circuits arranged independently for all-night arc lamps which are scattered throughout the buildings and outside. All the fuses used throughout the entire system are the "Noark" cartridge-type enclosed fuses, manufactured by the H. W. Johns-Manville Company, New York.

DISTRIBUTION SYSTEM.

Feeder cables lead from the switchboard in the power house through the piping tunnel to six distributing boxes in the locomotive shop, four of which are located at intervals along the length of the machine-shop section and the other two of which are spaced on the south wall of the erecting shop. The "inside" feeders for the intermediate voltages of the multiple voltage system, lead only into the four machine shop boxes, which are arranged in two pairs so that for each pair each intermediate wire to one box is simply tapped off from the similar one to the other so that the load on one box assists in balancing that on the other without the power being compelled to return to the power-house switchboard for the balancing effect. From the distribution boxes mains are run to eleven tablet, or panel, boards, situated at convenient points around the shop, and from these boards a separate circuit is carried to each tool, except for some long runs, such as that to the turn-table outside the north side of the shop, where tap-offs have been allowed. The engraving on the opposite page shows the general arrangement of one of these tablet boards located on a column in the machine shop.

The circuits to the tools in the heavy machine bay, over which there is a crane, and to a number of direct-connected tools in the light machine shop, are run underground, the wires being passed through loricated pipe, which is carried in a groove in the 3-in. plank floor and covered up by the 1-in. maple flooring on top. This system was adopted in preference to any elaborate system of junction boxes under the floor, as it was found that in order to keep the conduits out of the way as much as possible, and at the same time have the controllers in the most convenient position for the men operating the tools, it is necessary *not* to bring the pipe up within a few feet of the controller, but within a few inches of its best position.

This system of tablet boards has not been adhered to rigidly —in the erecting and boiler shops the tree system of "tap-off" wiring has been used. Leads are run between each pit in the erecting shop of sufficient capacity to operate two 5-h.p. portable motors in each of two pits on either side of a center track. Also these wires take care of the incandescent lighting in the erecting shop.

All the tools which are gear-connected to their motors are provided with single-pole overload-release circuit breakers, located at the sides, or back, out of reach so that they will not be thrown out wrongfully. This not only protects each motor from injurious overload, but prevents any general shut-down of the entire plant in case of accident to any tool. Each fuse on the tablet boards is considerably above the capacity of the circuit breaker on its circuit, being of sufficient size to allow for a failure of the circuit breaker and a heavy overload on the motor before it blows. Group motors on which

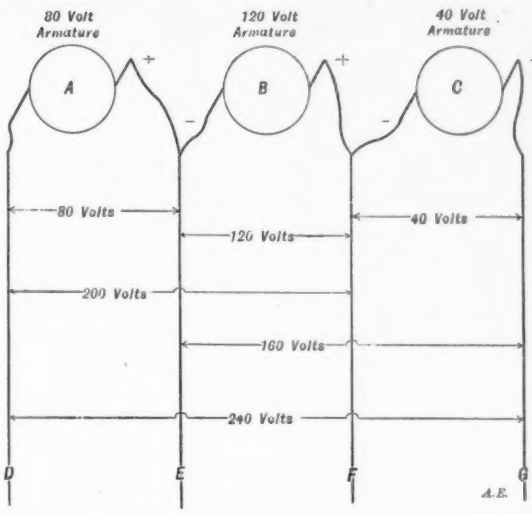


DIAGRAM SHOWING PRINCIPAL CONNECTIONS AND THE COMBINATIONS POSSIBLE WITH THE MULTIPLE VOLTAGE SYSTEM.

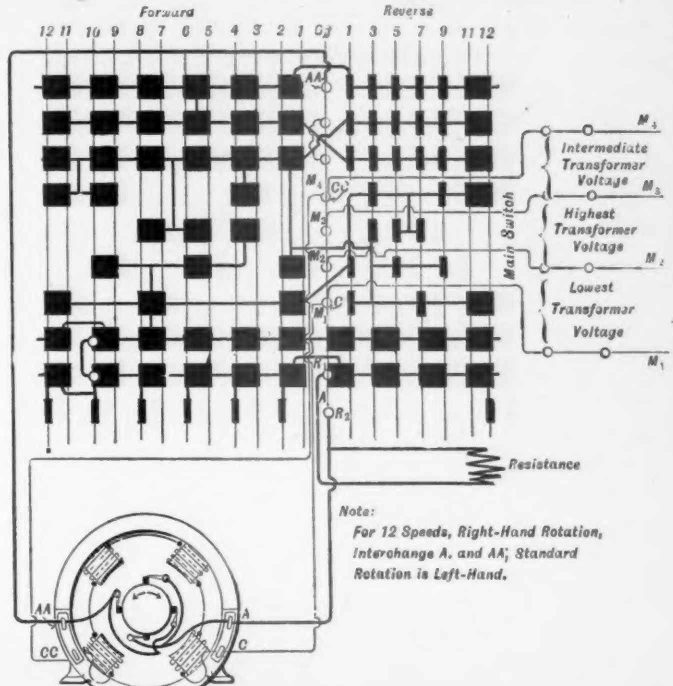
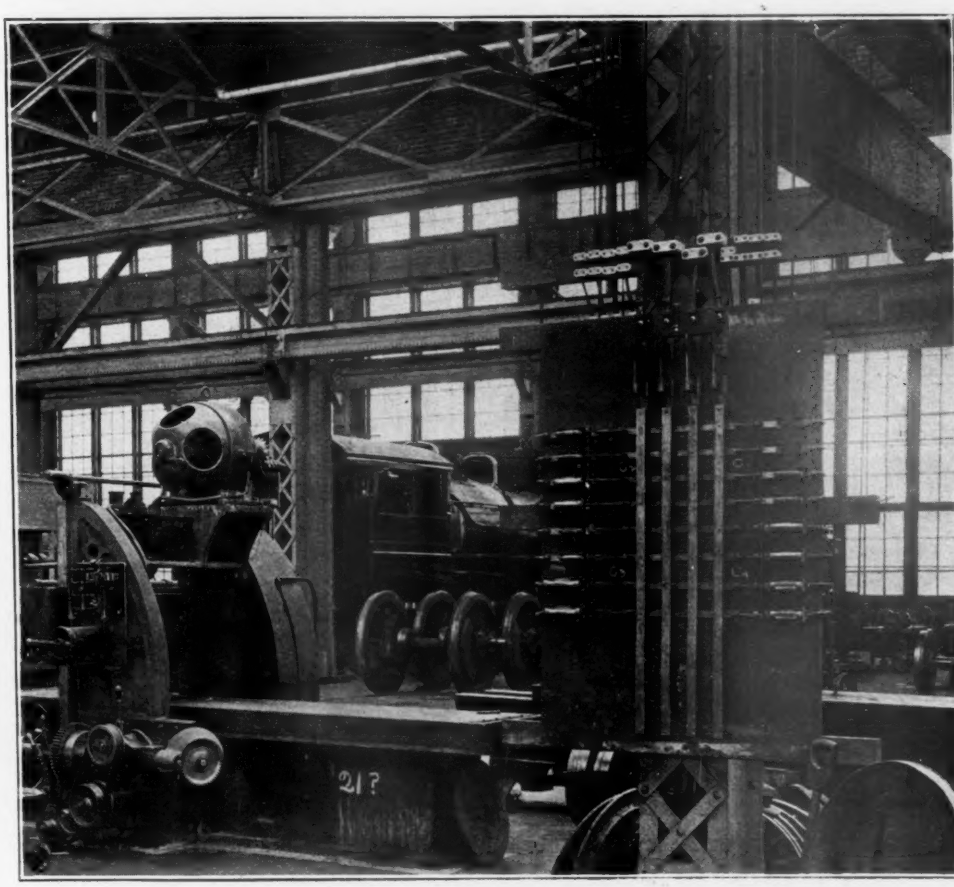


DIAGRAM OF CONNECTIONS OF THE CONTROLLER FOR THE MULTIPLE VOLTAGE SYSTEM.



VIEW OF A TYPICAL TABLET BOARD IN THE MACHINE SHOP, FROM WHICH FOUR MOTOR CIRCUITS ARE FED.

(Crocker-Wheeler motor-drive applied to a machine tool shown in background, showing location of controller, circuit-breaker, resistance box, etc.)

COLLINWOOD SHOPS—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

an excessive load is rather likely to occur are not provided with circuit breakers at all, but simply with fuses, which fuses are, however, of a capacity 50 per cent. above the rated horse-power of the motor; they are not intended to protect the motor against overload, except in case of its being extreme, such as might occur from a breakdown.

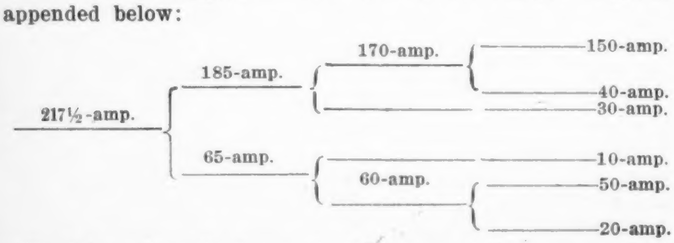
This principle of fusing far above the rated capacity of the motor attached to the circuit has been carried out throughout the entire electrical installation, using the fuse simply as a protection against a breakdown or short circuit. All fuses on the power circuits are also inclosed fuses of the "No-ark" type to enable them to be replaced with the least possible loss of time. All the wires in tunnel and open work are single-braid weatherproof insulated, and those under-

ground are rubber-covered. The circuit breakers used on the tools are the midget senior type made by the Cutter Company, Philadelphia, Pa.

This tablet-board system is about 10 per cent. more expensive than the tree or "tap-off" system, in which mains are run direct from distribution boxes and tap-offs lead off to each tool; but it has many important advantages. On the tablet boards are all the fuses for each circuit leading to a motor, so that if a fuse for any tool blows, the place to look for it is known and it can be instantly replaced. As each tool has a separate circuit, every one to which it is necessary to run the wires underground has all its wires in one piece of loricated pipe, so that if any defect develops in the insulation of the wires, there is no ground, but a short circuit, and it is instantly located and the wires can be drawn out and replaced.

There are also no fuses underground. Where shops are wired on the tap-off system underground without fuses, if a short circuit occurs the fuse will blow back on the distributing box, or switchboard, and all tools on that branch will be idle until it is replaced. Here the voltage at the tool is also far more constant, as one heavy tool near the distributing box cannot lower the voltage for all tools beyond it, but as the mains are carried near to the group of tools connected to them they all lower in voltage alike.

In calculating sizes of wires, a difficulty is occasioned by the fact that in mains and feeders the amperes can be reduced per horse-power on account of the number of tools rendering variations in power less noticeable and also on account of not all the tools being in use at once. At the same time the capacity must of course be sufficient to take care of the largest, or several of the largest, tools without excessive load on the wires. In the case of the feeders, this is not serious, as there are sufficient tools to average up satisfactorily, but in the case of the mains no rule depending upon amperes per horse-power and load factors is satisfactory. Therefore a progressively decreasing quantity system of calculating was devised in which all circuits are laid out on the branch system, and they are then combined in pairs, successively, back to the distributing box; in each combination the amperes on the joining wire are determined by adding half the smaller branch to the larger, as indicated by the sample diagram appended below:



By this system the heavy load is always taken care of and a fair margin is added to take care of the proportion of the smaller loads that may be in use. Of course, a different factor than one-half may be taken, as one-third, for instance, but it was found that by taking 4 to 7 amperes per horse-power in circuits and then reducing to 3½ or 3 on feeders and combining all circuits clear back to switchboard with the factor one-half, that the same results were obtained for feeders as with best information otherwise available. This system, which was devised by Mr. H. H. Vaughn, was found very rapid and satisfactory. Of course, different results can be obtained by combining in different ways, but the error is not large enough in this case to be serious. The feeders were figured to give 5 per cent. drops to centers of power, and then the circuits were adjusted to make the drops at tools not over 5 per cent.

The engravings upon page 25 show typical arrangements of motors for the motor drives in the machine shop. The illustration on page 23, which shows the rear of a planer-type milling machine, is particularly well adapted to indicate the convenient and compact arrangement possible for the motor, controller, resistance box and circuit-breaker.

THE MULTIPLE VOLTAGE SYSTEM.

In order to obtain variable speeds from the motors used upon the direct-driven tools, the multiple voltage system of the Crocker-Wheeler Company was installed for the speed controls, which system was referred to in relation to the generating equipment in the description of the power plant in our November number. This system consists essentially of several sources of current supply at different voltages, each differing by 40 volts, which may be each fed to the motor separately or in combinations, each different voltage and combination giving a different motor speed. This is accomplished as shown in the accompanying diagram, the armatures of the balancing rotary transformer being connected up in series with lead wires tapped off between each two and outside. This is, of course, merely an extension of the idea of the familiar Edison three-wire system, so much used in electric lighting; in this case, however, four wires are used and the voltages in the various branches of the system are not equal.

The changing of speeds of the motors is made simple by the use of controllers which, for the different positions of their handles, connect their motors to the various sources of supply and then to the various combinations in succession. Thus, for the starting position of the handle, a motor is connected to C (40 volts) only, and in later steps to A (80 volts) only, and then to B (120 volts) only; for still higher speeds the motor is connected in succession to B and C combined (160 volts), A and B combined (200 volts), and at last to A, B and C combined (240 volts), the highest voltage, which is taken from the "outside," or main lead, wires, giving the total dynamo voltage and is then independent of the balancing transformer. Each voltage applied to the motor gives it a different constant speed, 40 volts giving the lowest speed, used for starting only, and the other voltages, higher speeds up to 240 volts, the highest. With the Crocker-Wheeler controllers, as applied in this installation, intermediate speeds are made available between those offered by the various voltages and combinations by an armature resistance, giving 20 volts drop, inserted in the armature circuit at every other controller step. The diagram on page 23 indicates the arrangement of the complete connections for a controller governing a motor. The four small circles shown at M_1, M_2, M_3 and M_4 represent fingers of the controller which lead the supply current into the contacts on the drum. Each vertical line in the controller diagram represents a step of the controller for a certain definite speed, of which there are 12 forward and 6 reverse. The complete connections through the controller to the motor may be traced for each controller speed in the diagram by considering the 9 small circles, R_2, R_1, M_1, M_2, M_3, M_4, O, O and A A_1 (which represent the contact fingers of the controllers), as moved along to coincidence with the various vertical lines, in each of which positions they will be each in contact with a group of the contact plates (represented by the heavy black squares) furnishing the required connections. The first step connects the motor into the lowest voltage in series with the resistance, giving the 20-volt drop; the second step merely cuts this resistance out of the circuit; the third step connects up the next higher voltage again in series with the same resistance; the fourth merely cuts out the resistance again; and so on to the highest speed.

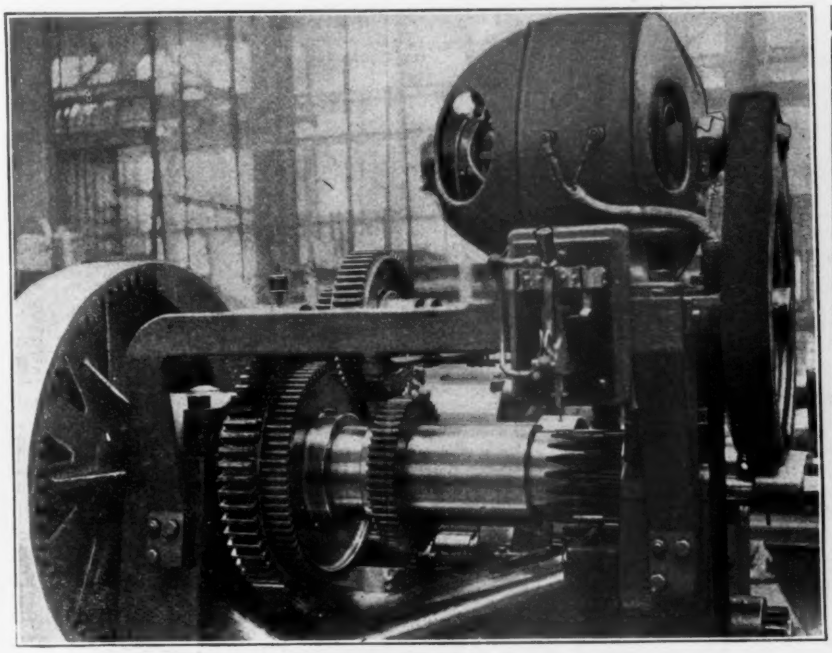
A notable feature of the Crocker-Wheeler controller is the fact that in passing from one step to the next in either direction, absolute contacts are ensured by a spring mechanism causing quick jumps from one position to another; this prevents the handle from remaining half way accidentally. Also the use of the resistance giving the 20-volt drop goes a great ways to effect smoothness in changes of speed. If the changes were made from one voltage to the next higher (which is in all cases a difference of 40 volts) the result would be a mechanical shock to the motor with each change; but the resistance reduces the jump one-half and thus effectually serves as a "cushion" to the motor at each change.

Below is presented in detail the information regarding the Niles electric cranes, which serve the various departments of the locomotive shop. This supplements the article that appeared last month. In the the following issue of this journal the information will be given regarding the machine tool equipment and methods of driving.

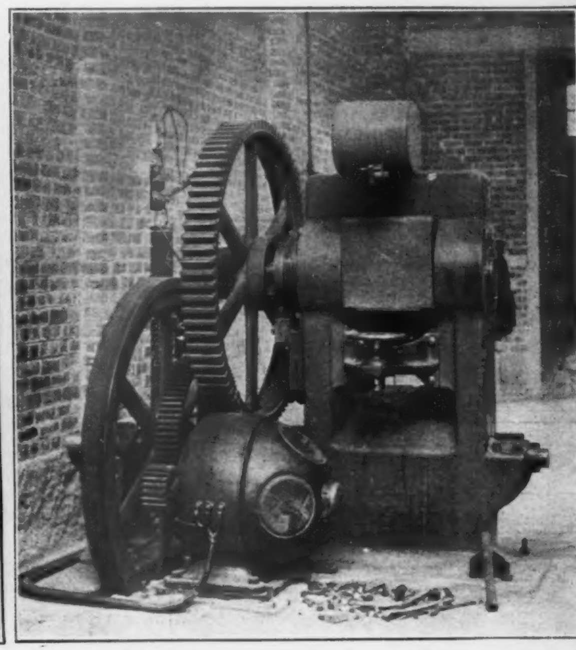
TRAVELING CRANES.

The arrangement of the four main electric cranes running full length of the locomotive shop are indicated in the drawings, pages 369-371 of our December, 1902, issue. The erecting shop is served by two cranes having different tracks, one a 100-ton crane with two 50-ton trolleys, and the other a 10-ton crane with a single trolley. The 100-ton crane, which runs on the upper track, has a span of 65 ft. 6 ins., with the tracks 38 ft. 4 ins. above the floor, while the 10-ton crane, on the lower track, has a 62-ft. 8-in. span, with tracks 26 ft. 3 ins. above floor.

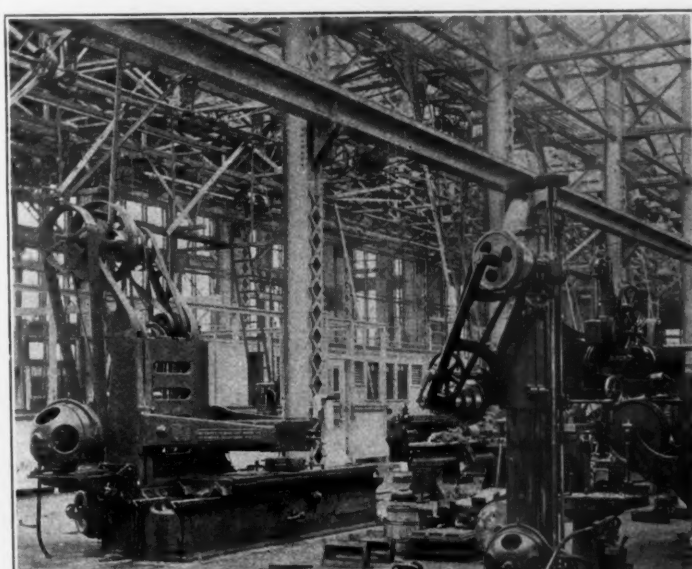
The lift of either hook of the 100-ton crane is 35 ft. 2 ins., which is sufficient to permit lifting of one locomotive entirely over the others. The test load submitted to each trolley of this crane was 125,000 lbs., its rated capacity being 100,000 lbs. each. The height over all of the crane above runway rails is 10 ft. 3½ ins. This crane is equipped with five motors, all operated at the dynamo voltage of 240 volts on the main two-wire system. The two main hoists are each equipped with 45 h. p. motors giving a hoisting speed of 10 ft. per minute at full load and 25 ft. per minute at no load; the trolleys each have 10 h. p. traversing motors capable of giving a trolley



DIRECT DRIVE ON A 28-INCH POND ENGINE LATHE.
(Motor supported on a specially designed framework above the headstock.)



DRIVE FOR A CINCINNATI PUNCH AND SHEAR WORKS BAR SHEAR.
(Showing convenient arrangement of motor and method of leading in wires.)



BELTED DRIVE FOR A DETRICH & HARVEY OPEN-SIDE PLANER AT LEFT — DIRECT DRIVE ON A BICKFORD RADIAL DRILL AT RIGHT.

DIRECT DRIVE ON AN 84-INCH NILES WHEEL LATHE.
(Showing convenient arrangement of motor and controller.)

TYPICAL INDIVIDUAL MOTOR DRIVES.

COLLINWOOD SHOPS—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

speed of 75 ft. per minute at full load and 100 ft. per minute at no load; the bridge is equipped with a 45 h. p. motor giving a full load speed of 150 ft. and no load speed of 200 ft. per minute.

The 10-ton crane has a 26-ft. lift of the main hook, its test load having been 25,000 lbs., and its height over all above the runway rails is 7 ft. 3 ins. Its main hoist has a 20 h. p. motor, giving a hoisting speed of from 20 ft. to 50 ft. per minute from full load to no load. The trolley has a 2½ h. p. traversing motor, with a speed of from 125 ft. to 160 ft., and the bridge is equipped with a 20 h. p. motor, giving a crane speed of 300 ft. to 375 ft. per minute.

The crane serving the boiler shop is a 30-ton crane with two 15-ton trolleys having a lift of main hook of 34 ft. 6 ins. Its span is 74 ft. 6 ins. and its height over all is 8 ft. 3½ ins. above runway rails. The test load of each trolley was 37,500 lbs. Each main hoist has a 20 h. p. motor giving a hoisting speed of 14 to 30 ft. per minute from full to no load; the traversing motors of each trolley are 2½ h. p. motors giving speeds from 110 to 150 ft. per minute from full to no load; the bridge motor is 30 h. p., giving speeds from 250 to 300 ft. per minute.

The 7½-ton crane in the heavy tool section of the machine shop has for its main hoist a 20 h. p. motor, giving a hoisting speed of 20 to 50 ft. per minute from full to no load; for the traverse of the trolley a 2½ h. p. motor, giving speeds from 125 to 160 ft., and for the bridge a 20 h. p. motor, giving speeds from 300 to 375 ft. per minute. Its span is 46 ft. 7 ins. and its height over all is 5 ft. 6 ins. above the runway rails, the test load of the hoist being 18,750 lbs.

All cranes have cut gears and the hoisting gear runs in oil, with dust-proof covering boxes. They were all supplied by the Niles, Bement, Pond Company, the well-known machine tool and crane manufacturers.

There are also three 1-ton hand-power traveling cranes with 17 and 18 ft. spans and short local travels in the light tool section of the machine shop. They all run on tracks 20 ft. 9 ins. above floor and are all arranged to serve local heavy tools. The crane in the riveting tower of the boiler shop is a hydraulic crane supplied by same pressure as to the riveter; its hoist is controlled by a hydraulic cylinder on the floor and its traverse and trolley motion is by hand. It was furnished by the Niles, Bement, Pond Company, together with the riveter.

An interesting special portable drilling machine has recently been placed in service at the works of the Dodge Manufacturing Co. which is adapted for saving time in mounting for drilling of the hub flanges for large segmental fly-wheels. The drilling machine is the standard radial drill of the latest type manufactured by the Bickford Drill and Tool Co., of Cincinnati, O., with the exception of the absence of the base, and other changes made necessary by the direct motor drive. The base has been entirely omitted and replaced by an extension of the column at its lower end into a short, slightly tapering stump intended to fit corresponding bushings which in turn, will fit the bores of the various sizes of wheel hubs. The electric drive consists of a constant speed motor with a vertical armature shaft and is mounted directly on top of the drill column, so that not only is it direct-connected to the gearing of the machine, but also it is in a position offering the least possible hindrance to handling and operation. The drive is through nests of gears which may be changed by hand levers to give eight changes of speed. The tool is mounted very quickly by means of the traveling crane in the bore of the wheel hub lying on its side, after which the spoke bolt holes may be drilled and reamed with the greatest facility. For rapid machining, together with economy of time in locating, this form of machine commends itself and suggests the possibilty of similar applications in locomotive repair work.

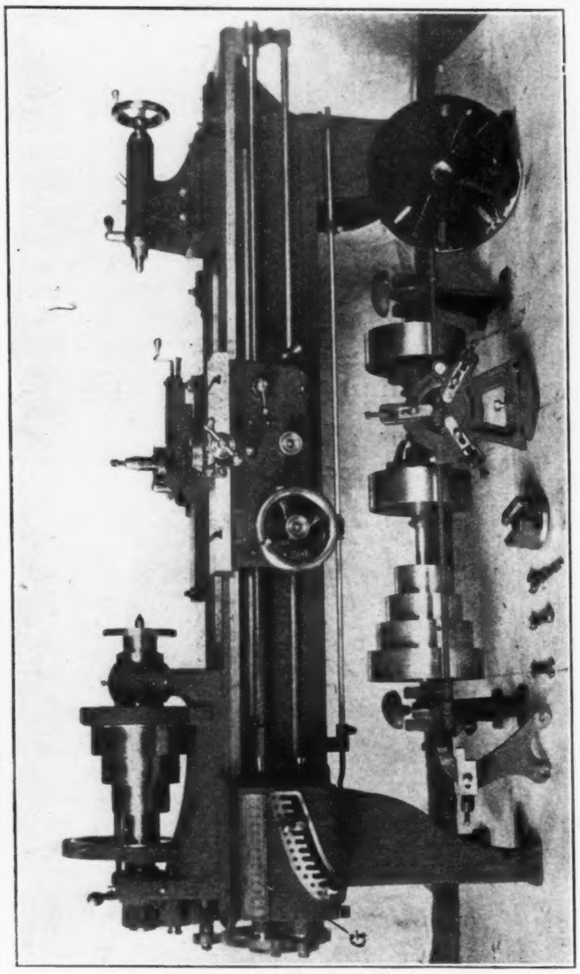


FIG. 1.—HENDEY-NORTON ENGINE LATHE, SHOWING ARRANGEMENT OF GEAR-BOX.

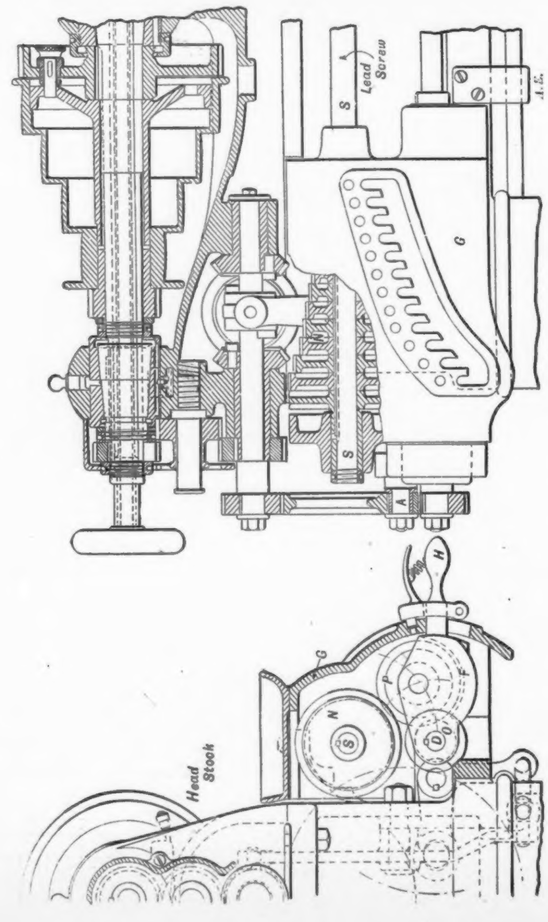


FIG. 3.—CROSS AND PART LONGITUDINAL SECTIONS OF HENDEY-NORTON GEAR-BOX.

MACHINE TOOL PROGRESS—FEEDS AND DRIVES.

MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

BY C. W. OBERT.

I.

The term variable-speed power-transmission device as here used is intended to refer to a self-contained mechanical arrangement interposed between a motor, or driving shaft, and the driven shaft, or machine, whereby power in the form of rotative motion may be delivered from the driving source to the receptive source at speeds which may easily be changed without removing belts or changing gears in the sense conveyed by the "change gear" method for screw cutting in engine lathe practice. The ideal limitation of the variable-speed device is, of course, the arrangement whereby the speed of transmission may be varied through an *infinite number of*

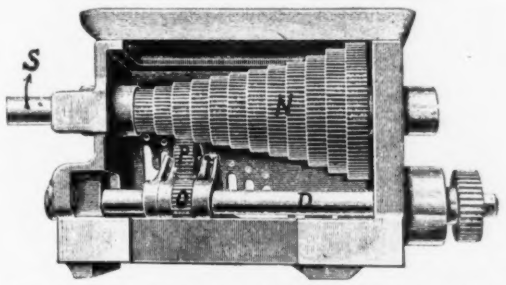


FIG. 2.—REAR VIEW OF GEAR-BOX, SHOWING GEARING.

variations, instantaneously, easily and *without any interruption* to the transmission of the power. Such an achievement has been incapable of realization in practice, even though many attempts have been made in this direction with some degree of success, especially with devices using the frictional-driving method of transmission. The greatest development has, however, been along the more practical line of the positive-drive method of transmission, and along this line many attempts have been made to perfect devices. It is hoped to be able to herein show along what lines true progress has been made and where mechanical limitations seem to have checked desired progress in other lines.

An examination of all the methods of obtaining variable speeds reveals the two general divisions of the subject according to the agency employed in transmitting the power, viz.: mechanical and electrical. Then the mechanical division is also divisible into subdivisions, according to the mechanism employed in the transmission, viz.: the positive-drive class, using gears, and the friction-drive class. In the positive-drive division of the mechanical methods only a very limited number of attempts have been made toward the design of mechanisms in which the speed may be changed without interruption of the transmission; in fact, the entire development of variable-speed apparatus in machine tool practice may be traced back to the well-known "back gear" method of obtaining two different speeds at the drill or lathe spindle from a constant-speed countershaft drive, which method involves necessarily a cessation of the transmission of power in changing speeds because toothed gears are used. The principal application of the mechanical gear-drive variable-speed device in machine tool practice is that of driving feed mechanisms; the use of the modern heavy lathes for hard-driven service in efforts toward increased profit-making has rendered belt-driven feeds undesirable and practically *requires* positive-geared feeds of wide ranges of speed, although it is by no means essential that there shall be no interruption of power while changing the speed of feed.

One of the earliest examples of a variable-speed feed mechanism of the gear-drive type is that which is applied by the Hendey Machine Company, Torrington, Conn., to their Hendey-Norton lathes. Their arrangement of gears is that of a nest of several gears of different diameters mounted on the driven shaft and a small spur gear revolving with, and movable lengthwise on, the parallel driving shaft, which spur gear is capable of being thrown into mesh with any gear of the nest. Fig. 1 shows a general view of an 18-in. Hendey-Norton lathe with this gearing device attached as shown at G. Fig. 2 is a rear view of the device detached from the lathe, and Fig 3 shows it in section. N is the nest of gears, all keyed to the lead screw shaft S, and D is a splined driving shaft parallel to the shaft, S, which receives its motion from the headstock spindle through gearing at A, in the usual way. Surrounding the shaft D is a bracket, or frame, F, Figs. 2 and 3, inclosing the pinion O, which feathers into and thus revolves with the driving shaft D, and also there is carried in this frame another pinion, P, which is mounted permanently in mesh with pinion O. This frame is controlled by the handle H. Fig. 3, outside the case, so that by moving the latter along the lower side of the large lateral slot in the front side of the case, the pinion P may be brought adjoining any of the gears in the nest; and then when it is desired to place it into mesh with any gear of the nest, the handle H is raised into the small vertical slot corresponding to that gear and locked

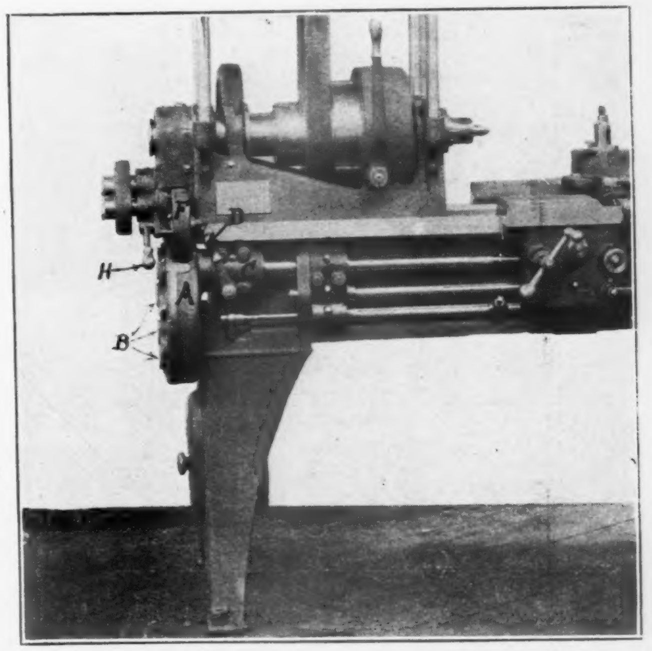


FIG. 4.—IDEAL LATHE, SPRINGFIELD MACHINE TOOL COMPANY, SHOWING CHANGE-GEAR BOX.

in that position. The small vertical slot guide and the locking attachment ensure the proper mesh and no interference with other gears.

This device, which is nothing more nor less than an adaptation of the idea of the cone pulley, is without criticism in the matter of simplicity, and as the gears are all of the same diametral pitch they must of necessity all work properly together. The large number of gears in the nest render quite a variety of speeds possible and with sufficiently gradual increments as to meet all possible requirements of ordinary lathe practice. A possible criticism is that the large slot in the front side of the case would admit dust and dirt in perhaps objectionable quantities. But as a device of its type, requiring cessation of transmission of power while changing speed, it has a great deal to commend it, both as to ease of change and to excellence of design in general.

The Springfield Machine Tool Co., Springfield, Ohio, have applied a similar but less effective device to the feeds of their lathes, consisting substantially of an attachment whereby the "change gears," as ordinarily used on lathes for varying feed

ratios, may be changed very quickly and in a simple manner. It consists of a gear box in which all the change gears are mounted, and means whereby the gear box may be readily adjusted so as to bring any one of the gears desired into connection with the lead screw. The gear case, which is shown at A, Figs. 4, 5 and 6, is a cast-iron box, the cover of which is capable of rotating about a stud, S, Figs. 5 and 6, at its center, and upon the inner side of which cover the change gears are permanently mounted. These gears have extension hubs which are fitted as journals into bearings in the cover to allow of rotation of the gears, and are held in position in their bearings by the collars, B, secured on their hubs outside of the cover. The holes shown in the protruding extension hubs at B, Fig. 5, are simply holes passing through the gear hubs for the clutching device. These bearings in the cover are arranged on a circle concentric with the stud, S, which circle is in line with the center of the lead screw, so that any of the gears may be placed

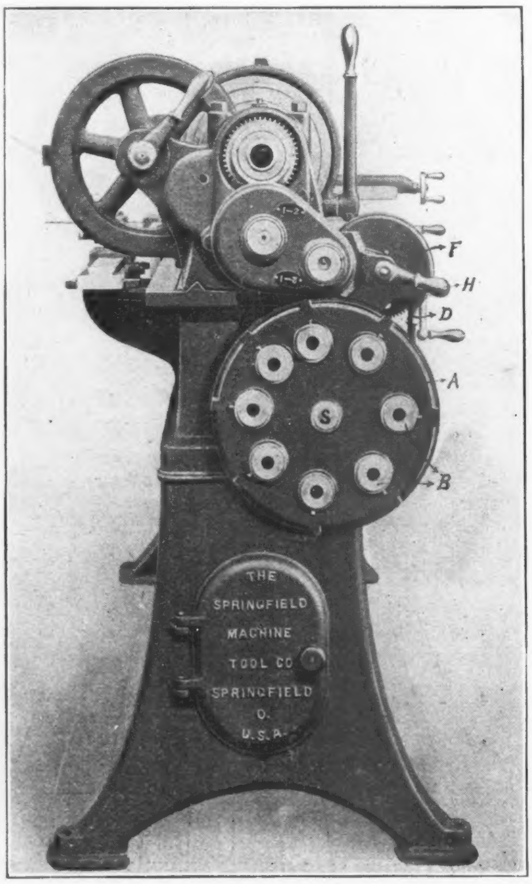


FIG. 5.—END VIEW OF IDEAL LATHE SHOWING METHOD OF SUPPORTING CHANGE GEARS BY THEIR HUBS.

opposite the end of the lead screw by simply revolving the gear case cover. For connecting any change gear to the lead screw, a clutching device, C, Fig. 4, is provided, which consists of a telescopically arranged extension of the lead screw shaft. This extension, N, Fig. 6, which is moved by lever D, is reduced at its end to enter the hole in the change gear, a distance equal to its width, before the clutches with which the change gears and the extension are fitted, engage with each other, so that when one of the change gears is connected with the lead screw, it ceases to depend on the gear case cover for support, but is substantially mounted on the lead screw. To connect one of these gears upon the lead screw it is simply necessary to bring that gear into position by revolving the gear case until the hole in its nub comes in line with the lead screw as shown by an indicator on the case, and then throw the clutch handle, D.

By the mounting of the change gears upon the inside of the gear case an effective guard is provided to protect the gears from dirt or injury, all of the eight gears being entirely concealed by the case except at the top where the intermediate gear, F, Figs. 4 and 5, enters to mesh with them. Thus this device has in this respect advantages over the former one, but, on the other hand it is, in reality, a retrogression from the ideal transmitter as compared with the Hendey-Norton gear box. The changes cannot be made nearly as quickly and they

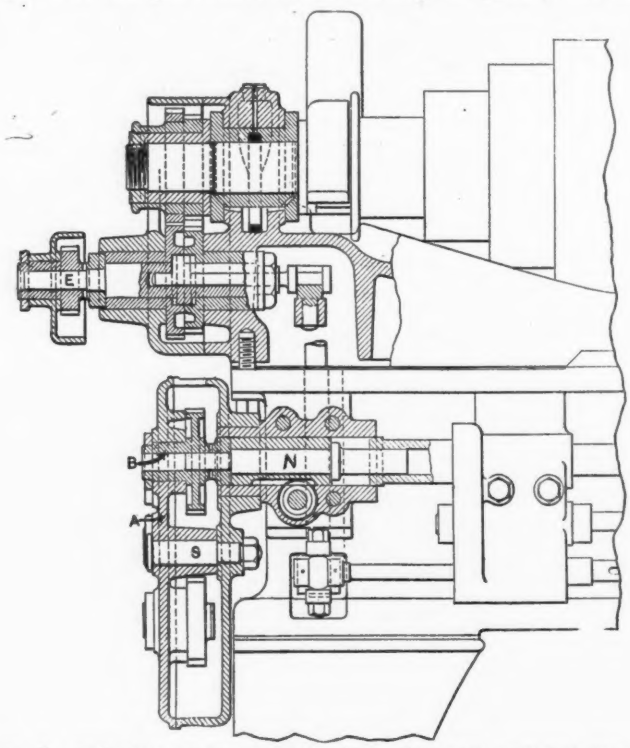


FIG. 6.—SECTIONAL VIEW OF IDEAL LATHE GEAR-BOX, SHOWING CLUTCH ARRANGEMENT.

involve considerably more care and trouble in being made; it requires three different operations or manipulations of parts for a single change of speed, while the Hendey-Norton gear box requires but one. The Springfield device has, however, to commend it the advantage of the fact that all the other change gears besides the one in mesh are at all times inoperative and at rest, so that there are far less parts in motion, and furthermore there is no possibility of the springing of an intermediate shaft as there might be in the Hendey-Norton box, as in this case each change gear is firmly mounted on the lead-screw shaft when in operation.

(To be continued.)

Mackinac Island is to be the place of meeting of the Master Mechanics' and Master Car Builders' Association conventions, June 17 to 24, with headquarters at the Grand Hotel. Applications for rooms should be made to Mr. Henry Weaver, Planters' Hotel, St. Louis, and applications for exhibit space to Mr. J. Alexander Brown, 24 Park Place, New York. It is a good place for a convention—"after you get there"—but it is difficult to understand why such an out-of-the-way place was selected. For the meeting place for the next convention the committee is recommended to consult Lieutenant Peary as to the possibilities of the Arctic regions.

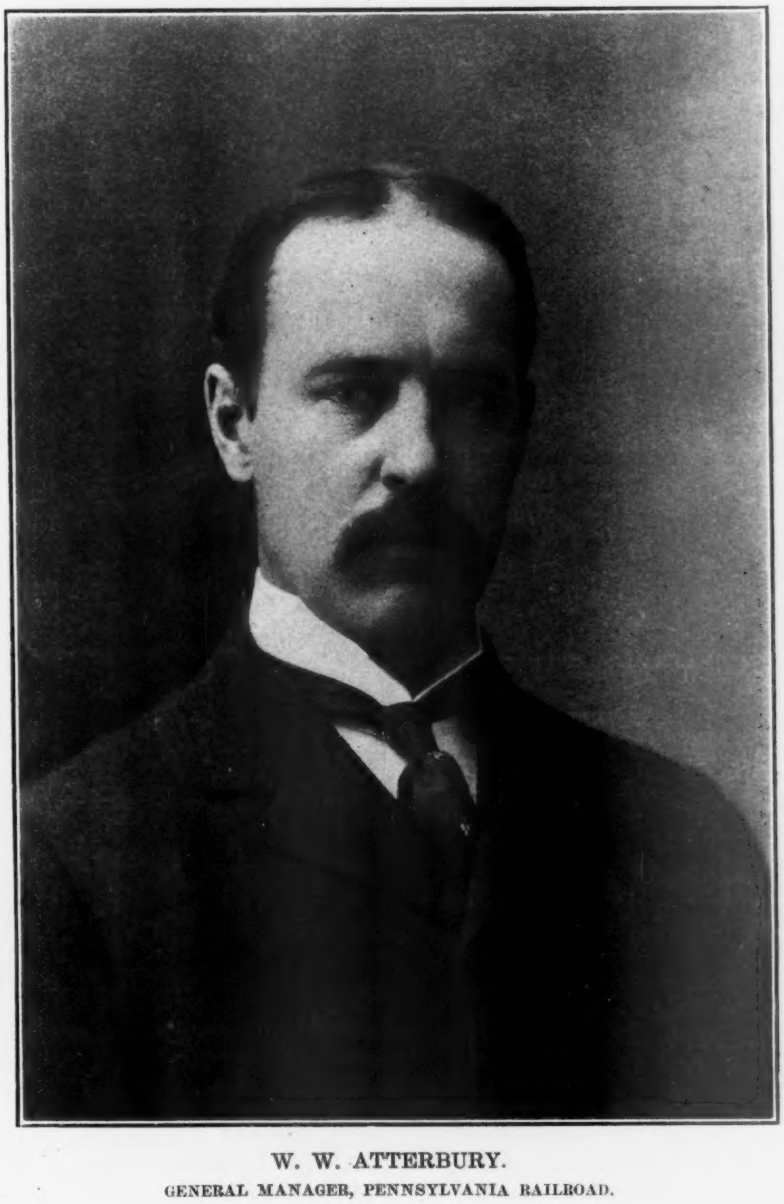
An interesting design for a box car with steel underframe is presented on another page in this issue. The construction illustrated seems to go back to the early stages of the steel car in this country, for, like the Harvey and Joughins designs, it employs truss-rods. This, however, is not a step backward in any sense, for the design is the work of an accomplished engineer, truss-rods being used for a definite purpose. It is hoped that readers will consider this design carefully and express their opinions upon it through these columns.

W. W. ATTERBURY.

Mr. W. W. Atterbury has been appointed general manager of the Pennsylvania Railroad to succeed Mr. J. B. Hutchinson who, because of ill health, has been relieved of the responsibilites of this position.

The appointment of Mr. Atterbury is another important recognition of motive power experience as a preparation for operating responsibilities. Mr. Atterbury is 37 years of age. He was born at New Albany, Ind., in 1866, and it is safe to say no man of his age has ever attained so high a position on the Pennsylvania.

He is a graduate of the Sheffield Scientific School of Yale University, class of 1886, and entered the employ of this road in October of that year as a special apprentice, his time in this service being reduced because of previous experience in machine shops at Detroit. July 1, 1889, he was sent out as assistant road foreman of engines of the Philadelphia division, where his executive work began. He was transferred to a similar position on the Pittsburg division and afterward went to the P. W. & B. R. R. in the same capacity. In 1892 he went to the Pennsylvania Lines as assistant engineer of motive power and became master mechanic at Fort Wayne in 1893. October 26, 1896, he received the appointment of superintendent of motive power of the Pennsylvania Railroad division and upon the resignation of Mr. Casanave, became general superintendent of motive power of the lines east of Pittsburg, October, 1901. In 17 years he has risen from apprenticeship to the position of general manager. This record, his experience and ability, will unquestionably place him much higher in the councils of this great railroad.



W. W. ATTERBURY.
GENERAL MANAGER, PENNSYLVANIA RAILROAD.

For a number of years he has been active in the Master Mechanics' and Master Car Builders' Associations, and wherever his name appears in the proceedings of these organizations it is in connection with important work which has been characteristically well done. He is also a member of the American Society of Mechanical Engineers and of a number of social clubs of the highest standing.

Mr. Atterbury is succeeded as general superintendent of motive power by Mr. A. W. Gibbs, formerly superintendent of motive power of the Philadelphia, Wilmington & Baltimore.

SOME INTERESTING NEW DRIVING-WHEEL LATHES.

EXTRA HEAVY AND OF SPECIAL DESIGN FOR VERY RAPID CUTTING.

The Niles Tool Works Co., Hamilton, Ohio, have recently installed in some prominent railroad repair shops of the country several interesting extra heavy driving-wheel lathes which involve in many respects departures from existing practice. The engraving on the following page presents a front view of a driving-wheel lathe of special design recently built by the Niles Company for the Altoona shops of the Pennsylvania Railroad. It is arranged for individual electric drive, being equipped with two General Electric Co. direct-current motors, one on the left headstock for the main drive and the other at the rear for shifting the right-hand headstock of the lathe.

This lathe is designed to take very heavy cuts, using the new highly-efficient, self-hardening steel for tools, the capacity of the machine with respect to the size of the work being tires on driving-wheels ranging from 52 to 68 inches in diameter on tread. The face-plates are 72 inches in diameter and are driven through internal cut-gears of gun iron with which they are fitted, the gears having 100 teeth of 2-in. pitch and 7-in. face. A novel feature is introduced in that openings are provided in the face-plates, as shown in the left plate, for the purpose of receiving the crank-pins of the driving-wheels, permitting mounting the wheels close up to the face-plates, which greatly simplifies the method of driving them and largely reduces the strains resulting from the drive. The main spindles of the machine are of high-grade gun-iron, with front or main bearings 13 ins. diameter by 16 ins. long and rear bearings 10 ins. diameter by 14 ins. long, these bearings being bronze boxes of the usual construction permitting of adjustment for wear. The internal sliding spindles carrying the centers are 7 ins. in diameter, being made from steel forgings.

The carriages and tool-rests for this lathe are of great

strength and massiveness of construction. The tool-rests are provided with lateral adjustments on the carriages and also the necessary swivelling adjustment for turning the tapers on the treads of the tires. Two tools are at present being worked in each tool-rest by means of specially arranged tool-post fittings, which causes each two tools to act as a gang. The feeds for the tool-rests are driven by ratchets operated through the rocker arm and shaft shown at the right-hand front corner of the bed, the rocker arm being driven positively by one of the driving shafts at the rear of the bed. The lathe as equipped is intended for turning tires only, but by slight modifications it may be adapted for turning journals also. Also quartering attachments may be applied to both heads of this machine, although they can work simultaneously only on pairs of wheels having left-hand lead, but the smallest radius for which this lathe can be set for quartering is 13 ins. on account of the large size of spindle.

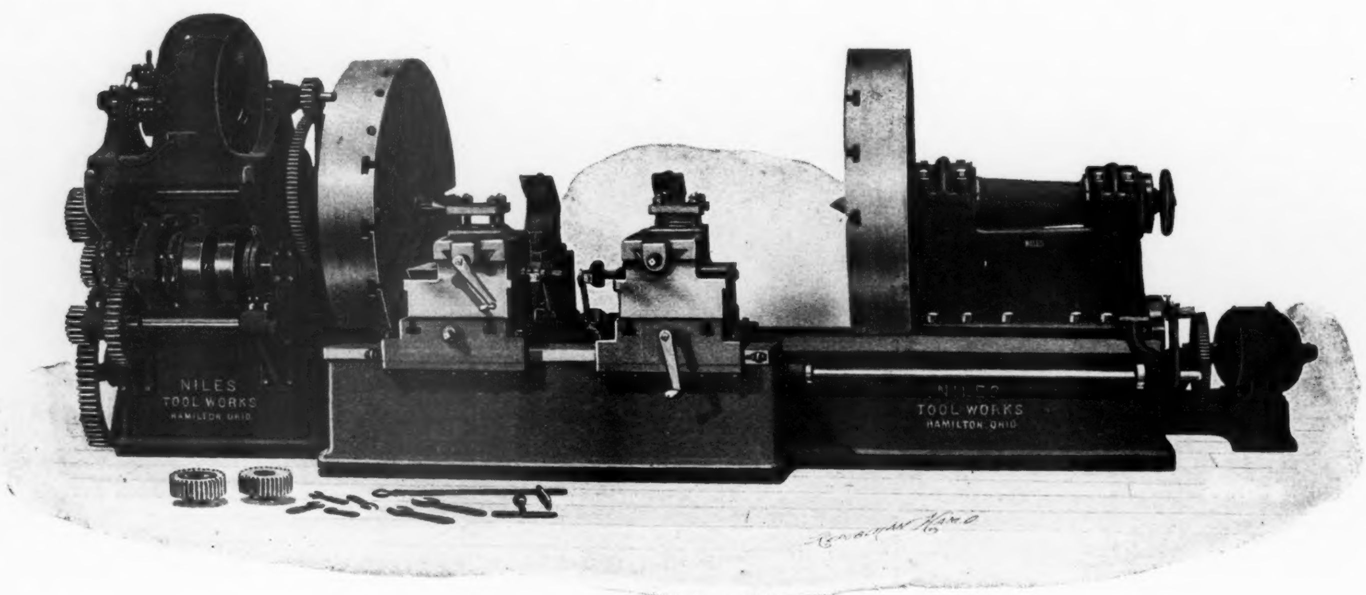
All of the gear-carrying shafts between the main motor and the face-plates run in bronze bearings, and all of the gears are of close grain gun-iron and the pinions of steel forgings, all having cut-gear teeth. The gearing and shafts are all designed to safely withstand a pressure transmitted which will bring a pressure of 18,000 lbs. at each tool post—this is probably about as heavy a pressure as our best tool steels of today will withstand when worked according to modern practice. Such a capacity as this is a revelation to the wheel-lathe practice and the possibilities which are open to it for rapid production are difficult to predict.

The main drive of this lathe is from the 25 h.-p. variable-speed, direct-current motor shown mounted above the main headstock of the lathe. This motor, which has a range of speed from 600 to 840 rev. per min. by field regulation, drives through trains of gears and a magnetic clutch by means of which, together with the change gears which are provided for the gear trains, a range of cutting speeds is available, varying from 10 to 30 ft. per min. on any diameter of tire within the capacity of the machine, and also a special extremely slow speed of from 4 to 6 ins. per min. The extremely slow speed is desirable for use when cutting through the hard spots that are so frequently met in turning steel tires, and it was for this purpose that the magnetic clutch device was applied. The other motor at the rear is a 3 h.-p. motor for use in adjusting the position of the right-hand headstock.

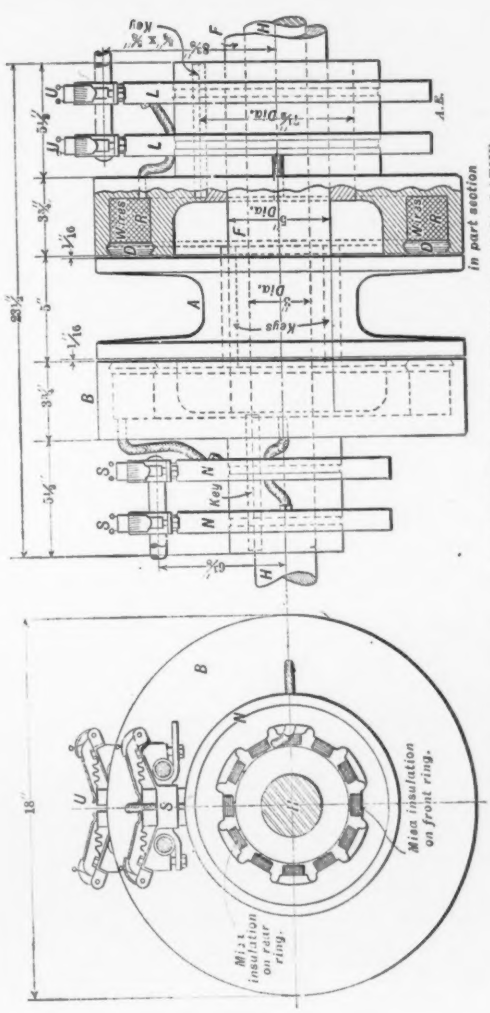
The magnetic clutch as here applied is of particular interest, as it is utilized for changing to an extremely great reduction of speed rather than for reversal of motion, its usual application heretofore. The form of clutch used is the iron-clad annular magnet type of magnetic clutch which was originated by the General Electric Co. for reversing planers in connection with positive motor driving. The accompanying diagram shows its construction. The two annular clutch magnets are shown at B and D, D being shown in part section to indicate the arrangement of the exciting coil, and between them is the common armature, or "keeper," A, upon which either may act. The magnets consist merely of 18-in. steel discs with grooves milled in their inner faces, which grooves are each filled with a coil of magnet wire, as shown at R-R; the coils are held in position by rings of lead, D-D, poured in while molten and calked in place, the heavy insulation of each coil preventing injury to it. The terminals of each coil are carried out through the rear of the disc to two collector rings, L-L, and N-N, mounted on extended hubs, and into these the current for either coil is fed by the carbon brushes, S-S and U-U.

When current is thrown into either magnet, it draws the armature, A, up against it and causes the armature, by the friction due to the pressure of the contact, to revolve with it. The armature, A, is keyed directly to the hollow shaft, F, which drives the main shaft and through gearing the two face-plates of the lathe. Clutch, B, is keyed directly to the inner shaft H, which is driven from the motor for the higher speeds, and clutch, D, is driven through a special spiral gear on its hub for the extreme low speed, both clutches revolving in the same direction. Each clutch when in action requires only $1\frac{1}{2}$ ampere of current at a voltage of 110 volts, and has a capacity of transmitting 18-brake horse-power at 142 rev. per min.

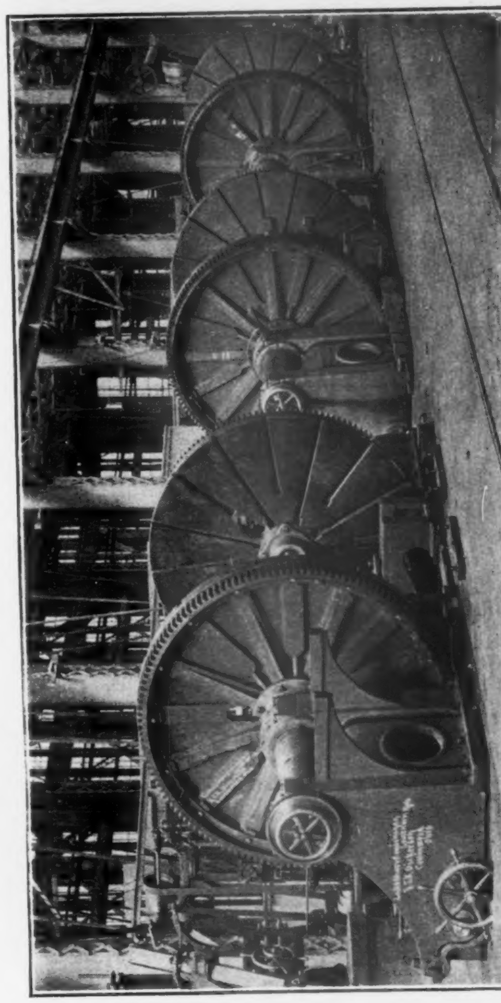
Thus when clutch, B, is thrown into action the face-plates are driven at the usual cutting speeds of from 10 to 30 ft. per min., as required, but when B is thrown out and clutch, D, thrown in, the slow speed of 4 to 6 ins. per min. is started up. The change from one to the other may be made instantaneously by merely throwing a switch from one contact to another. A great advantage of the application of this magnetic clutch—one which has largely been lost sight of—is the fact that it offers to the positive motor drive all the advantages of belt driving that have been lost through the use of gearing; the possibility of slipping when the tool is badly overloaded, which acts as a protection to the motor and which so characterizes belt drives, is an advantage of considerable



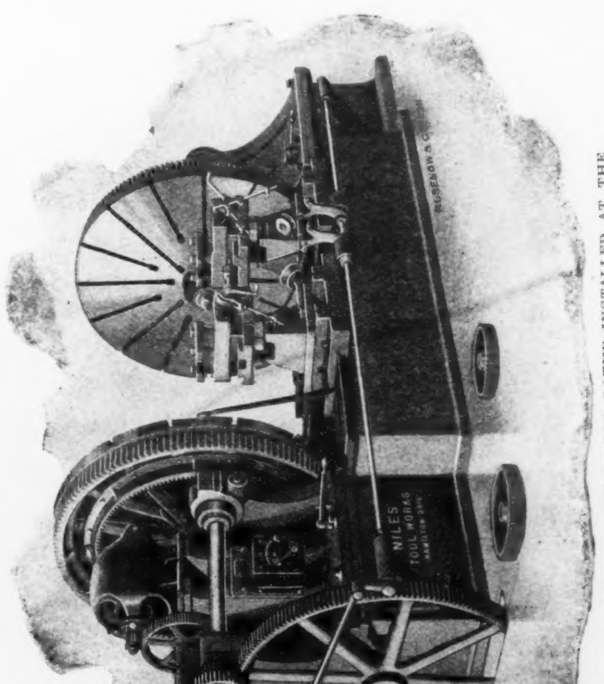
HEAVY NILES DRIVING-WHEEL LATHE, ELECTRICALLY DRIVEN THROUGH A TWO-SPEED MAGNETIC CLUTCH. INSTALLED AT THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.



DETAILS OF THE TWO-SPEED MAGNETIC CLUTCH USED ON THE ALTOONA LATHE. DESIGNED BY THE GENERAL ELECTRIC COMPANY.



THE THREE 84-INCH NILES DRIVING-WHEEL LATHES INSTALLED IN THE COLLINWOOD SHOPS OF THE LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.



HEAVY 90-INCH NILES DRIVING-WHEEL LATHE INSTALLED AT THE BLOOMINGTON SHOPS OF THE CHICAGO & ALTON RAILWAY.

value in the magnetic clutch. The magnetic clutch, as well as the two motors used upon this lathe, were furnished by the General Electric Co., Schenectady, N. Y.

The engraving at the left is a view of a very heavy 90-in. driving-wheel lathe, which the Niles Tool Works has recently installed at the Bloomington shops of the Chicago & Alton Railway, and of which type and size they have lately supplied two machines to the Chicago & Northwestern for their West Chicago shops. The view above on this page shows the three 84-in. driving-wheel lathes that have been installed at the new Collinwood shops of the Lake Shore & Michigan Southern Railway by the Niles Co., each of which is direct driven by a 12-speed Crocker-Wheeler motor of 15 h.-p. operating on the direct-current multiple-voltage system.

These lathes are all arranged so that the face-plates may be driven together, or separately, as desired, each head having a clutch for disconnecting its driving gear. The right-hand heads are arranged for six speeds, while the left-hand heads have 12 speeds, six of which are rapid for boring work. Each face-plate is detachable for replacing in case of breakage. The main spindles are of cast iron, each having internal sliding spindles capable of extending sufficiently to support the wheels with crank-pins in place.

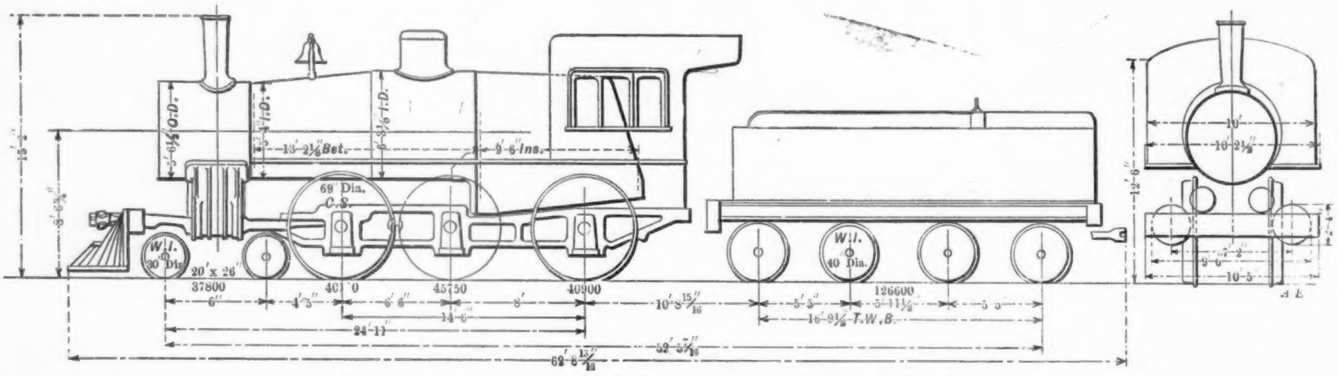
The tool-rests have power feeds at all angles and in two directions when once set. The bed is made high in front to permit of short tool posts of great strength and stiffness for withstanding the stress of heavy cutting, while the rear is made low to facilitate rolling in the wheels. The right-hand heads in these machines, as well as the carriages, are traversed by hand power. These machines are also adapted for the use of quartering attachments on either face-plate, the boring spindles for which are held by face-plate guides close up to the work.

CANADIAN PACIFIC PASSENGER LOCOMOTIVES.

4—6—0 TYPE.

BUILT BY THE CANADIAN PACIFIC RAILWAY.

This new design of locomotive for the Canadian Pacific is of special interest because it represents the ideas of Mr. E. A. Williams, superintendent of rolling stock of this road, and Mr. A. W. Horsey, chief draftsman; also because six of them are to be built by Nelson, Reid & Co., of Glasgow, Scotland, in addition to twelve which are being completed at the Delorimer avenue shops of the road in Montreal. The first of them was built last August, and at present six are running and giving excellent results. It is impossible at this time to present more than the diagram showing the general proportions of the engine.



PASSENGER LOCOMOTIVE. 4—6—0 TYPE.—CANADIAN PACIFIC RAILWAY.

These engines have piston valves with inside steam admission and outside exhaust, with steam ports made as direct as possible. Special care was taken in designing the valve gear, to get it straight and direct, with little opportunity for springing or lost motion to distort or restrict the steam distribution. The piston valves are in line with the centers of the frames and there is no motion bar. A rocker is used, journaled on a pin secured to the frame, the valve stem being long and perfectly straight. Both rocker arms are inside the frames. The driving-spring rigging is underhung and is made central with the driving journals. In keeping down to a maximum of 46,000 lbs. per pair of wheels it was necessary to slope the back boiler head, and this gives a roomy cab. For a number of years this road has used cabs of steel with rounded corners. This and the "turtle-back" tenders give the engine an attractive appearance. Ten-inch steel channels were used in the construction of the tender frame, and it is very strong. These are handsome engines. This road gives special attention to attractive outline and good appearance of its locomotives. We hope to illustrate the valve motion in a later issue.

CANADIAN PACIFIC RAILWAY.

4—6—0 Type.

Passenger Locomotive.

Weight on drivers	126,750 lbs.
Total weight	164,500 lbs.
Cylinders	20 x 26 ins.
Driving wheels, diameter	69 ins.
Boiler	Radial stayed extended wagon top
Boiler pressure	210 lbs.
Tubes	336—2-in., 13 ft. 2 ins. long
Firebox	114 x 42 ins.
Heating surface, tubes	2,262 sq. ft
Heating surace, firebox	159 sq. ft.
Heating surface, total	2,421 sq. ft.
Grate area	332 sq. ft.
Driving journals	9 x 12 ins.
Engine truck journals	6 x 10 ins.
Tender journals	5½ x 10 ins.
Tender, water capacity	5,000 gals.
Tender, coal capacity	10 tons
Tender, weight empty	56,000 lbs.
Tender, weight loaded	126,600 lbs.

BETTER CAST IRON CAR WHEELS.

Speaking of improvements in car-wheel iron, Mr. C. V. Slocum, in a paper before the Pittsburgh Railway Club, said: "Our own experiments with the metal demonstrate that titanium in iron gives greater density to the metal, surprisingly increases transverse strength and gives a harder chill or wearing quality in the wheel. This is no light statement when it is remembered that the tread, or wearing surface, of a car wheel is already harder than steel—in fact a rough section of chilled car-wheel iron will cut glass. The clearly demonstrated practicability of supplying in one casting a wheel with a hard tread for wear and a soft hub for machine work, with strength only limited by the price which the purchasing agent is willing to pay for it, makes the chilled cast-iron wheel stand forth as its own probable successor in carrying the heavy traffic of the future."

A rail 250 ft. long has been rolled at the Hoerde Works, Germany. It was exhibited at the Dusseldorf exhibition. One of the Krupp exhibits was a hollow bored shaft for a steamer forged in a single piece in a length of 148 ft. The core was lying beside it. The ingot from which this shaft was made required the contents of 1,768 crucibles and the pouring was performed in 30 minutes by 490 workmen. Crucible steel ingots up to 85 tons are cast at Essen and open-hearth steel ingots up to 120 tons.

It has been reported in Chicago that there is another project on foot for the development and utilization of the power made available by the flow of water from the Chicago Drainage Canal, which empties into the Des Plaines River above Joliet. A dam is to be located some distance below Joliet, the necessary options having been obtained upon the land lying along the river which would be overflowed.

A grill room chair car has been introduced into the Chicago & Alton passenger service between Chicago and Kansas City. Anything from a sandwich to a champagne supper is served from a small 8 by 10 ft. kitchen in one end of the car, the grill room being fitted up after the style of small American dining rooms with tables for six people.

Remarkably low steam consumption for Sulzer engines (Winterthur, Switzerland) is recorded in *Engineering News*. In tests conducted by Professors Weber and Schroeter the consumption was 8.97 and 9.41 lbs of steam per horse power hour superheated and 11.98 and 11.57 lbs. saturated. The power developed was about 3,000 horse power.

Interest in superheating, as applied to locomotives, is increasing in Continental Europe. The Prussian State Railways have placed an order for the equipment of twelve express, the same number of passenger and freight and fifteen freight locomotives with the Schmidt system of superheating.

REMARKABLE LOCOMOTIVE PERFORMANCE.

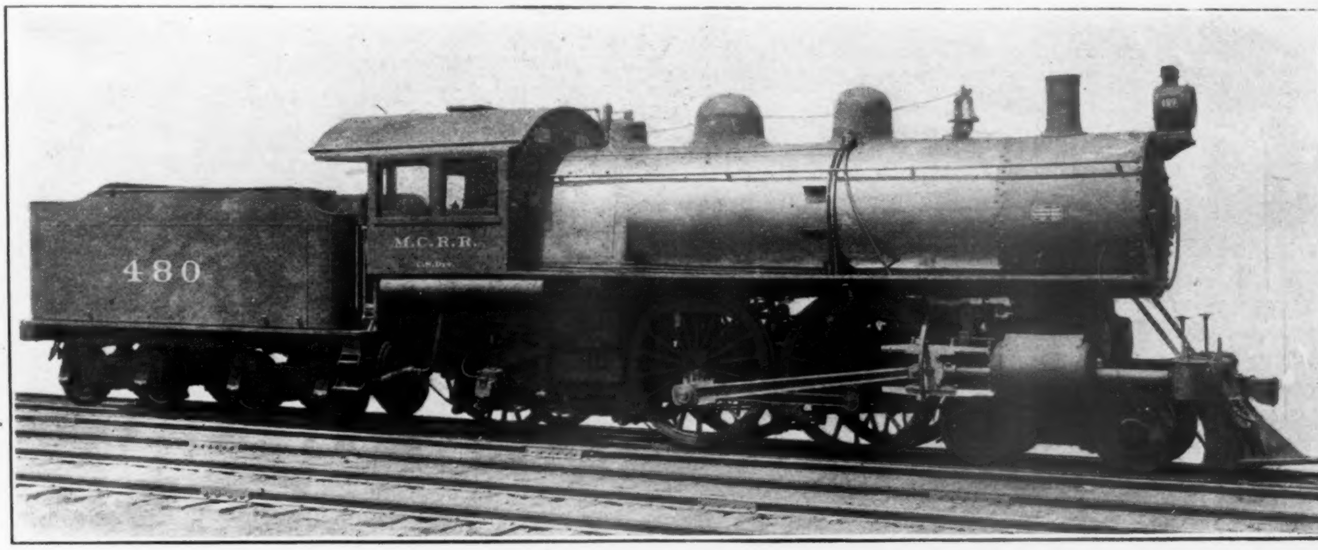
MICHIGAN CENTRAL RAILROAD.

Through the courtesy of Mr. E. D. Bronner, superintendent of motive power of the Michigan Central, the record of a recent very fast run with a heavy train on that road has been received. The engine was No. 483, of the 4—4—2 type built by the Schenectady Works of the American Locomotive Company and similar to those of the same type on the New York Central. The train of 16 passenger equipment cars weighed 605.55 tons and was hauled 168.22 miles in 127 minutes—at the rate of 55.8 miles per hour. There were eight slow-downs. Considering these and the weight of the train, this record is believed to be unsurpassed. The weight of the engine with a half tank of water and coal is 125.62 tons, making a total of 731.19 tons, including the engine and tender. The weight 605.57 tons is that back of the tender. This run of 55.8 miles per hour. This would call for a mean effective pressure of about 88 lbs. and the probable horse-power developed would be about 1,900 h.-p. In the absence of indicator cards these figures are estimated, and also the figures of 142 lbs. of coal per square foot of grate per hour with which this work is believed to have been done.

This photograph is of another engine of the same class as No. 483, the chief dimensions being as follows:

Michigan Central 4—4—2 Type Passenger Locomotive.

Weight in working order	176,000 lbs.
Weight on drivers	95,000 lbs
Weight engine and tender in working order	280,000 lbs.
Wheel base, driving	7 ft.
Wheel base, total	27 ft. 3 ins.
Wheel base, total, engine and tender	52 ft. 10½ ins.
Diameter of cylinders	21 ins.
Stroke of piston	26 ins.
Kind of slide valves	Piston
Greatest travel of slide valves	6 ins.
Outside lap of slide valves	1 in.
Inside clearance of slide valves	⅛ in.
Lead of valves in full gear	Line and line
Diameter of driving wheels outside of tire	79 ins.



4—4—2 TYPE PASSENGER LOCOMOTIVE.—MICHIGAN CENTRAL RAILROAD.

BUILT BY THE AMERICAN LOCOMOTIVE COMPANY, SCHENECTADY WORKS.

demonstrates the value of this able boiler with 3,521 sq. ft. of heating surface, and of the large grate. The record of the run is as follows:

RECORD OF THE RUN.

Station.	Time.	Mins.	Miles.	Miles per Hour.	
Bridgeburg	A 8.13 A. M.				
Bridgeburg	D 8.19 A. M.				
Victoria	8.21	2	0.81	24.30	Yard limits
Niagara Junction	8.24	3	1.27	25.40	Yard limits
Stevensville	8.30	6	5.06	50.60	
Brookfield	8.35	5	5.44	65.28	
Welland	8.40	5	4.71	56.52	Slow down
Perry	8.50	10	9.34	56.04	Slow down
Attercliff	8.59	9	8.22	54.80	
Canfield	9.07	8	7.33	54.98	Slow down
Edward	9.12	5	4.82	57.84	
Hagersville	9.24	12	11.57	57.85	Slow down
Townsend	9.30	6	5.57	55.70	
Villa Nova	9.32	2	2.25	67.50	
Waterford	9.37	5	4.93	59.16	Slow down
Windham	9.44	7	6.57	56.31	
Pt. Dover Junc.	9.48	4	4.13	61.59	Slow down
Hawtrey	9.49½	1½	1.23	49.20	
Cornell	9.54½	5	5.08	60.96	
Tilsonburg	10.00	5½	5.44	59.35	
Brownsville	10.06	6	5.79	57.90	
Springfield	10.11½	5½	5.47	50.67	Slow down
Aylmer	10.14	2½	2.46	59.04	
Kingsmill	10.17	3	2.74	54.80	
Yarmouth Crossing					Slow down
St. Thomas	A 10.26	9	7.99	53.27	Yard limits
		127	118.22		

The train consisted of eight New York Central coaches, one baggage and mail car, one express car, five Michigan Central coaches and one Pullman sleeper. The cars weighed 1,081,150 lbs. and the contents (estimated) 130,000 lbs. Such a train would require a tractive effort of about 13,000 lbs. at a speed

Thickness of tire	3½ ins.
Diameter and length of driving journals	9¼ ins. diameter x 12 ins.
Diameter and length of main crankpin journals	6½ ins. diameter x 7 ins.
Diameter and length of side-rod crankpin journals	7 ins. diameter x 4¼ and 5 x 3¾ ins.
Engine truck, journals	6 ins. diameter x 12 ins.
Diameter of engine truck wheels	36 ins.
Boiler, outside diameter of first ring	72⅛ ins.
Boiler, pressure	200 lbs.
Firebox, length	96⅛ ins.
Firebox, width	75⅜ ins.
Firebox, depth	Front, 80¼ ins.; back, 69 ins.
Tubes, number	398
Tubes, diameter	2 ins.
Tubes, length over tube sheets	16 ft.
Fire brick, supported on	Water tubes
Heating surface, tubes	3,314.75 sq. ft.
Heating surface, water tubes	27.09 sq. ft.
Heating surface, firebox	180 sq. ft.
Heating surface, total	3,521.84 sq. ft.
Grate surface	50.3 sq. ft.
Exhaust nozzles	5¼—5½—5¾ diameter
Smokestack, inside diameter	14 ins.
Smokestack, top above rail	14 ft. 9 ins.

Mr. J. W. Duntley, president of the Chicago Pneumatic Tool Company, has returned from a remarkably successful European trip. One of his purposes was to establish a new plant, which was accomplished. It will be located at Fraserburg, in Scotland, will cost $175,000, and will be equipped with American machinery. This is the third European factory for this concern. Mr. Duntley brought back with him orders for 2,500 pneumatic tools. Without doubt the number is large because of the campaign of education which the company has been carrying on in Europe through skilled American mechanics, sent over to demonstrate the value of these tools. The company has made several changes among its representatives in the United States. Mr. George A. Barden has been transferred from Buffalo to Philadelphia, Mr. C. R. Green has been transferred from Cleveland to Buffalo, and Mr. Charles Parsons looks after the Northwest section.

PHENOMENAL MILLING MACHINE WORK.

Among some machine tools recently purchased for use in railroad shops, we notice a large number of milling machines made by the Cincinnati Milling Machine Company, Cincinnati, Ohio. Their plain miller, having a table of 16 ins. wide with 42 ins. travel, has several points of particular advantage for railroad shops. One of the strong features in its design, which has attracted a great deal of attention and won the approbation of master mechanics generally, is the method of driving the feed; instead of driving the feed screws by a belt and cone pulleys from the spindle, a train of gears is used, making an entirely positive drive, so that the relation between the revolutions of the cutter and the feed of the work to the cutter is always positive. This feed mechanism is so designed as to be the strongest part of the machine; all the gears are drop-forged steel with cut teeth, and hence, as there is no slippage possible between the main spindle and the feed screws, the operator can depend upon the work being fed to the cutter as long as the machine continues in operation.

Another feature of this mechanism is that the rate of feed can be changed in an instant at any time no matter how fast the spindle is turning or how heavy a cut is being taken. The position of the feed-changing lever always shows by the raised figures on the lever quadrant just how fast the machine is feeding; this gives the foreman an exact index as to what the operator is doing at all times, which is recognized as a very valuable feature by up-to-date mechanics.

This machine finds its chief application in railroad shops in milling driving boxes, connecting-rod brasses and work of a similar character. Fig. 1 shows one of these machines in operation on some work which will give an idea of how this class of work is handled. In this case the material is cast iron and the recess being milled is 6 ins. wide and 15-16 in. deep. The entire width of the gang of cutters is 7⅝ ins. and the largest cutter is 4½ ins. in diameter, with a 6-in. face. The cutters work at a surface speed of approximately 47 feet per minute. The roughing cut takes out about 3-32 in. all around with a feed of .075 in. per turn of cutter, which is equivalent to a table travel of 3 ins. per minute. Then the feed is reduced by means of the quick feed-changing mechanism, described above, the cutters are changed and a finishing cut is taken, removing about .010 in. all around at the reduced feed of .036 in., or nearly 1½ ins. table travel per minute. On this job two cuts are taken because extreme accuracy is required, the finished pieces coming within a limit of .001 in.

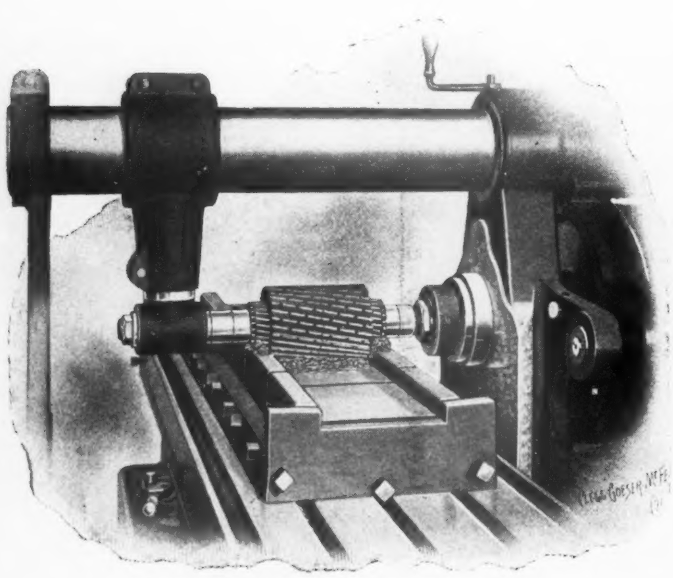


FIG. 1. AN EXAMPLE OF RAPID MILLING.

This company also makes universal milling machines which are especially designed for tool-room work, for which the No. 3 size has been most popular. This machine has a table 12 ins. wide, with 30 ins. travel, and weighs approximately 4,000 lbs. It has the same feed mechanism as that described above for the No. 4 plain miller, and on both machines there are 16 changes in the rate of feed, the slowest feed being .006 in. and the fastest feed being .300 in. per revolution of cutter.

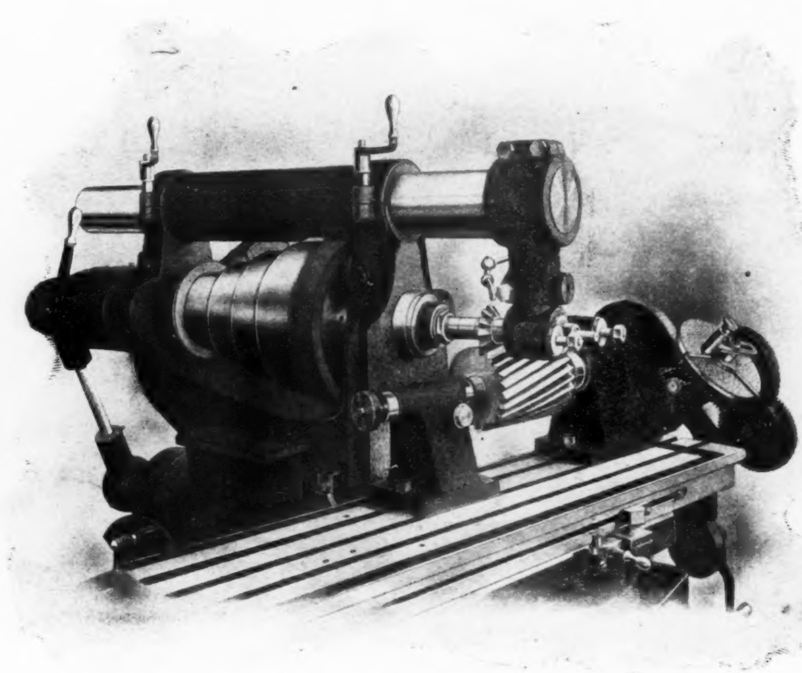


FIG. 2. A NEW RECORD IN MILLING STEEL.

Fig. 2 is an illustration of this latter machine in operation. The blank being milled is made of unannealed tool steel, 5½ ins. diameter, and the teeth are cut at a 14-deg. angle. The grooves are ½ in. deep and about ¾ in. wide at the top. The stock is removed at a table feed of ¾ in. per minute, the machine working quietly without any chatter. A light finishing cut is then taken at a table feed of 1 5-64 ins. per minute. This beats all records even over the larger machines of other makes and several of the best-known cutter makers in the world have adopted this machine as their standard. The machine shown in Fig. 2 is the regular universal machine with the exception of the spiral head. In this case a head made especially for spiral work is substituted for the universal indexing and dividing head regularly supplied with the machine. The Cincinnati milling machine has been installed in the shops of a large number of prominent railroads in the United States.

The Cincinnati Milling Machine Company have pamphlets illustrating characteristic milling operations and giving complete data of same, which they are always pleased to send to parties interested. The interesting feeding mechanism of these machines will be taken up in detail in a later issue of this journal.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The annual meeting of this society was held in New York December 2 to 5, the presiding officer being Vice-President Arthur M. Waitt, who presided ably in the absence of the president. The first and last sessions were held in the rooms of the society and the others in the banquet hall of the Sturtevant House, near at hand. In accordance with a recommendation from the council the following committees were appointed: To co-operate with the American Institute of Architects in tests of large I-beams, Messrs. H. de B. Parsons and Professor Palmer C. Ricketts. As a committee on the standardization of screw threads, Messrs. Wilfred Lewis, G. R. Stetson, G. M. Bond, C. C. Tyler and John Riddell. To represent the society on the committee to fix the next award of the John Fritz medal, Prof. G. Lanza, Prof. J. E. Sweet, S. T. Wellman and R. W. Hunt. Ninety-three names were added to the list of membership.

The subject to which most time was given was the metric system, which was vigorously attacked in a paper by F. A. Halsey, who proved conclusively that experience with the metric system in other countries justified the conclusion that if adopted by a compulsory law in the United States for the business of all departments of the government, the result would be an addition to the confusion already existing. He showed that the metric countries have, in a large degree, maintained their former systems and the ideal conditions expected from the metric system have not been attained abroad. An altogether undue amount of time was given to this subject, the discussion being decidedly unfavorable to the system and resulting in a resolution to the effect that the society has never, officially, withdrawn its opposition to it.

Among the other papers was one by Mr. Wm. Kent, entitled "Heat Resistance the Reciprocal of Heat Conductivity." Mr. Kent advocated the use of reciprocals of the usual values of heat conductivity so that the conductivity of a combination of substances may be obtained in the same manner as is the case in electrical work. Mr. Chas. T. Porter presented a paper constituting an argument for finer screw threads. Mr. C. C. Tyler described the use of a surveying instrument in the floor plate work of the machine shop of the General Electric Company at Schenectady. Mr. Frank Richards discussed "Gift Propositions for Paying Workmen," in a paper which was, by far, the most important of the meeting. This paper is discussed, editorially, in this issue. The discussion developed the fact that the author of the paper was in the minority. Most of the speakers took the ground that it was not necessary to give all the advantage of increased output to the men and that the management should have a direct profit in order to accomplish reduced cost per piece for the work turned out. While Mr. Richards' view was not a popular one, it behooves men in charge of industrial establishments of all kinds to consider his criticisms most carefully. It is hoped that our readers will secure copies of his paper from Professor F. R. Hutton, secretary of the society, 12 West 31st street, New York. Of the remaining papers the most important was by Professor A. Kingsbury, describing a new oil testing machine and its results, which were remarkable in uniformity.

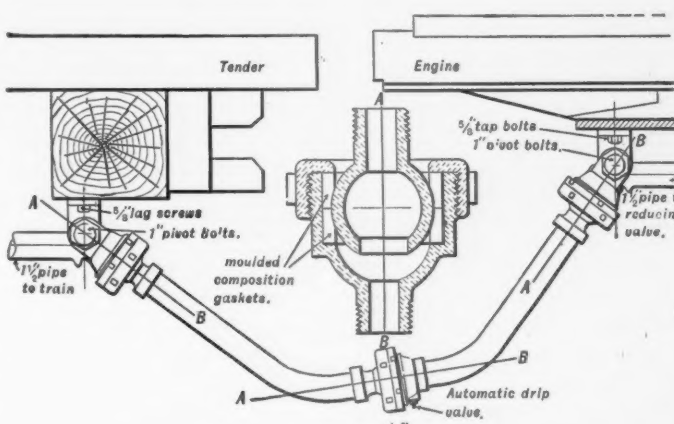
In this entire meeting there was no direct reference to railroad subjects and the proceedings can hardly be said to have reflected the progress which has been made in a number of other lines of engineering. There is an undercurrent of criticism on this account. The election of officers resulted as follows:

President, James M. Dodge, Philadelphia; vice-presidents, F. H. Daniels, Worcester, Mass.; James Christie, Philadelphia, and J. R. Freeman, Providence, R. I.; managers, R. C. McKinney, New York; S. S. Webber, Trenton, N. J., and Newell Sanders, Chattanooga, Tenn.

THE MARTIN FLEXIBLE METALLIC CONDUIT.

For steam, oil, water and air connections between locomotives and tenders a more permanent material than rubber hose has been sought. The Holland Company have introduced a new form of metallic conduit with flexible joints which seems to meet the necessities of such service admirably. Such connections must not only be durable and flexible, but they must be steam-tight, and for oil, which is not usually under high pressure, the test of tightness is a severe one for a flexible joint. After more than three years of experimental work Mr. J. C. Martin, Jr., has developed the conduit which is illustrated by this engraving, and the writer of this description has watched tests of the joints under high steam pressure where there was certainly no leakage.

As shown in the sectional view, the tightness of the joint does not depend upon a fit of metal to metal, as the metallic surfaces do not come into contact. For this reason the metal surfaces will not wear out. Around the ball are placed two gaskets of hard material specially manufactured for this purpose. They are molded to fit the ball and are interchangeable. One of these gaskets receives the wear of the joint while the other makes it tight. A sleeve nut holds the joint together and the gaskets may be easily renewed when necessary without disturbing the threaded pipe connections. The material of the gaskets furnishes its own lubrication and in ordinary service they are expected to give a service of one year. The engraving also shows the complete conduit with three joints. The center joint has a straight passage with more than the full opening of the pipe, while the others must necessarily cause a quarter turn in the passage. An important feature of the device is the fitting containing the angle bend. It is of malleable iron and is fastened by a bolt to a malleable iron supporting casting secured to the engine and tender frames. These fittings provide a flexible attachment without in any way placing a strain on the piping. Moreover, this form of attachment provides for a considerable difference in elevation of the ends of the conduit by merely changing the angles, as indicated in the engraving. In all the joint fittings the passages are larger than the area of the pipe. All of the parts, including the pipe, are furnished complete, ready for attachment. Bronze is used for the joints and malleable iron for the attachments. The joints are fitted with automatic drip valves, as indicated. It will be noticed by examining the sectional view that this joint does not depend upon the pressure of the fluid for its tightness.



MARTIN METALLIC CONDUIT.

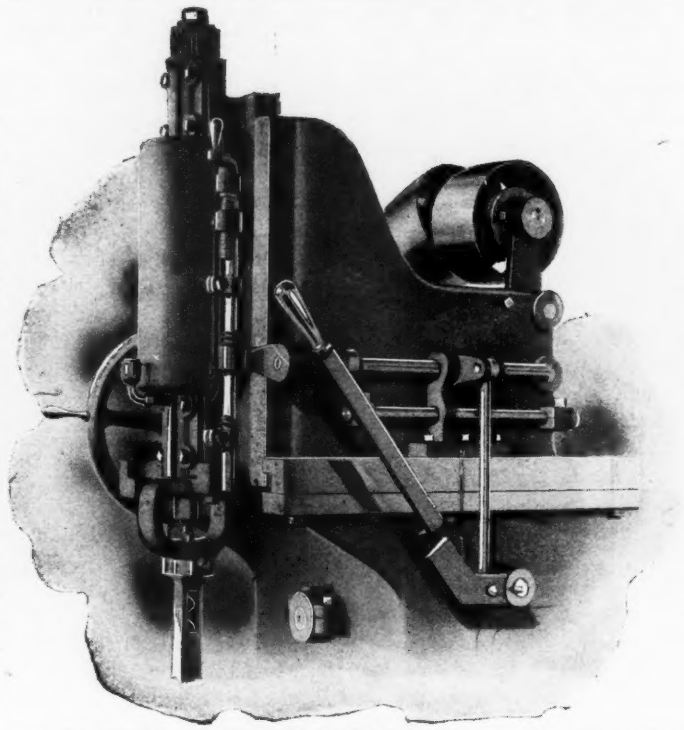
The conduits have been put into service on a number of leading railroads and satisfactory results are reported. The chief offices of the Holland Company are at 77 Jackson Boulevard, Chicago. Other offices have been established in New York and in San Francisco.

VERTICAL HOLLOW-CHISEL MORTISER.

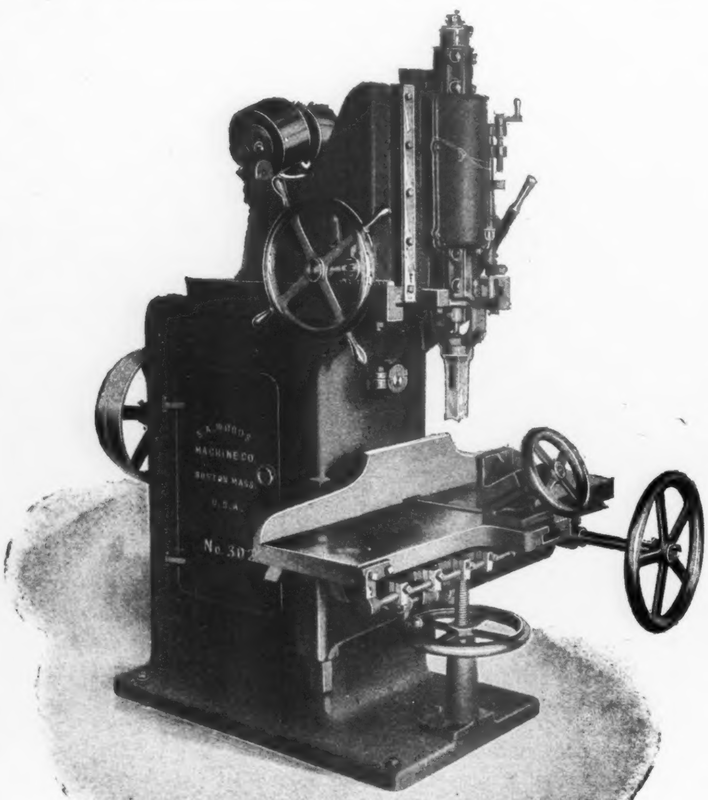
S. A. Woods Machine Company.

These engravings present a new vertical, automatic, hollow-chisel mortiser which has received the best thought and is the result of the wide experience of this well-known concern. It is built for fast and economical work and an inspection of the engravings gives the impression of the same sort of care in designing the machine as is given to the highest grade machine tools which are absolutely indispensable to railroad officers who are engaged in efforts to conduct their work upon business principles. Nowadays the convenience of the operator must be considered or the operation of a machine cannot be economical. In this case all of the operating and controlling devices are placed within easy reach and they do not require even a step in the manipulation. This is exceedingly important. A machine must be convenient to the operator.

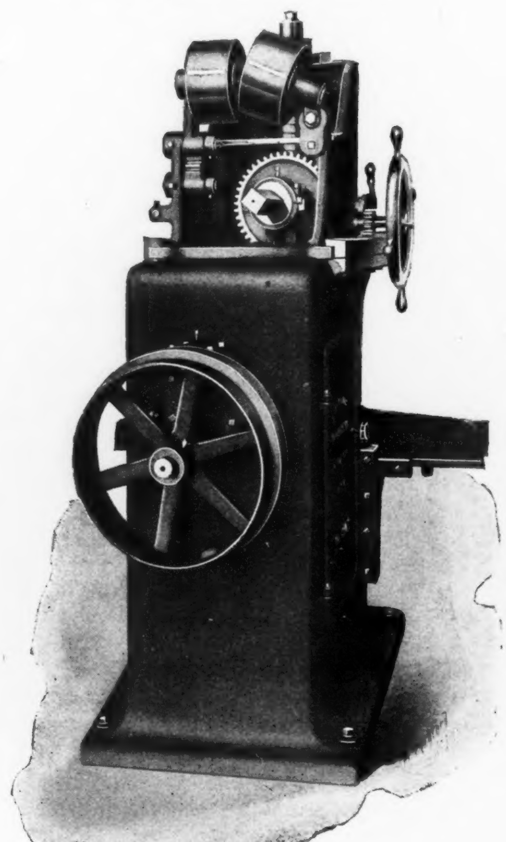
Among the special features of the construction the following attract our attention: The lay-out stops for laying out mortises should contribute to quick and accurate work. For taking up the end thrust of the spindle and supporting it, an improved step bearing, running in a bath of oil, is provided. The machine has a new device for instantly changing the depth of the mortise. The spindle belt is kept tight by an automatic belt-tightener, which is seen in the rear view. When the chisel is located in position it is locked by a novel clamping device and the chisel carriage has a transverse movement with adjustable stops for regulating its travel. In this respect the machine presents a new feature for a medium-size machine and one which is sure to be appreciated. The table has both vertical and longitudinal movements, the chisel ram being also vertically adjustable. The timber clamp is very strong and is adjustable as well as detachable from the table. Improved friction feed with two speeds is provided, with quick return. To prevent air-cushioning of the belts a patented pneumatic spindle is employed.



SHOWING DEVICE FOR CHANGING DEPTH OF MORTISE. ALSO, LAYOUT STOPS FOR TRANSVERSE MOVEMENT.



VERTICAL HOLLOW-CHISEL MORTISER.



REAR VIEW.

The chisel ram has a vertical travel of 9½ ins., the chisel carriage moves horizontally 18 ins. and will drop to mortise stock 17 ins. high with a 6½-in. chisel. Timber up to 12 ins. may be clamped and chisels up to 1½ ins. can be used on hard wood. The floor space occupied is 4 ft. x 5 ft. 8 ins. The manufacturers present the machine with confidence. They say: "This is a machine we are extremely proud of and we cannot say too much in its favor." This of itself is a strong recommendation. Further information may be obtained from the S. A. Woods Machine Company, South Boston, Mass.

THE DE LAVAL STEAM TURBINE COMPANY'S NEW FACTORY.

An interesting and enjoyable feature of the New York meeting of the American Society of Mechanical Engineers last month was a trip to the factory of the De Laval Steam Turbine Company at Trenton, N. J., which was tendered to the members by the D'Ollier Engineering Company, of 74 Cortlandt street, New York, the contracting engineers for the installations of the De Laval turbines. Access was given to the machine shop and the testing room of the factory, where the turbines were to be seen in all stages of assembling and testing, and in all sizes from the smallest up to 300-h. p. units.

The compactness of the De Laval turbine, due to its characteristic high speed, was made particularly evident; a blade-disc for a 50-h. p. turbine was shown which is only 9 ins. in diameter and runs at a speed of 20,000 revolutions per minute, giving thus a circumferential velocity of about nine miles per minute. The blade disc for their largest unit, the 300-h. p. turbine, is only 30 ins. in diameter and runs at a speed of 10,000 revolutions per minute, giving a circumferential velocity of over 15 miles per minute. This high speed is not utilized directly, but the power is delivered through a 10 to 1 reducing gearing consisting of two pairs of carefully cut spiral gears, each pair of which has oppositely inclined spirals, so as to produce the herring-bone gear effect and neutralize thrust. The result of this combination is very smooth and quiet running.

One remarkable property of these turbines is their economy; they have proved so economical that the makers can very easily guarantee a steam consumption of only 15½ lbs. of steam per brake horse-power-hour. They also have proved almost as economical at partial loads as at full load. A remarkable performance is accomplished by the 300-h.p. turbine-generator set which has supplied the factory since its opening—it is now running 24 hours per day, on account of the night shift, steadily without shutdown throughout the week. It would be a rare service for a reciprocating engine to run 130 hours per week between shutdowns without giving trouble.

MECHANICAL STOKERS IN ROLLING MILLS.

Perhaps the severest character of load encountered in modern steam-supply service is that encountered in the operation of steel rolling and slabbing mills. The fluctuations in the demand for steam are not merely of the nature incident to a street-railway load, which is usually considered of maximum severity, but they frequently involve the capacity of the entire plant. In one American steel plant there have recently been put into operation slabbing mills consuming as much as 2,000 horse-power during the working of a large steel "bloom." This load is approximately uniform until the "bloom" leaves the rolls, when it instantly decreases to that of mechanical friction only. It is apparent that in order to effectually accommodate these excessive variations in steam supply either a considerable storage capacity must be provided in the boiler equipment, permitting uniform firing, or quick steamers must be employed, fired by some form of mechanical stoker. At the present time the latter arrangement is rapidly coming into use, with the result that fluctuating loads are readily anticipated and cared for by control of fuel combustion. This control may be rendered automatic when mechanical draft is employed in connection with the boiler and stoker equipment. A prominent example of this arrangement is offered in the plant of the Lukens Iron and Steel Company, which comprises 5,700 horse-power capacity of Babcock & Wilcox water-tube boilers equipped with Roney improved duplex stokers and a complete mechanical draft outfit. In this plant the speed of the fans and the position of the flue-dampers are automatically controlled by the pressure of steam in the supply-main, thus proportioning the rate of combustion to steam demand. In the operation of this plant it has been found unnecessary to continue the signal system formerly in use between fire-room and slabbing mill, and the heaviest demands for steam are readily provided for by the automatic arrangement for control of draft in connection with the mechanical stokers.

A new device for the delivery of train orders to engineers and conductors of trains in motion has been patented by Mr. Amos McKanna, of Emporia, Kan. It consists of a clip holding the train order, which is suspended on a large wire ring. The ring is held in clips from the end of a rod, which is held in the hand of the operator, and the ring with the train order is easily caught by the arm of the men on the engine and caboose. For use at night a torch on the end of the arm may be lighted in order to attract attention and permit of sure operation of the device.

BRAZING CAST-IRON.

At a meeting of the Foundrymen's Association of Philadelphia, December 3, Mr. H. Armor Ward, president of the American Brazing Company of 136 South Fourth street, Philadelphia, explained in detail a new process.

In the course of his remarks Mr. Ward stated that the discovery of the process of brazing cast iron had changed the methods in European foundries with reference to complicated castings, especially in the case of large castings where a flaw or imperfection of any kind involved the relegation of the piece to the scrap pile.

The patterns were now cut into two or more parts, so that each was a simple piece to mold, and the several parts that went to make up the whole were brazed together, and the cost of production had been materially reduced, in that the cost of brazing was very much less than the cost of molding one large casting, as against two or more smaller pieces.

Mr. Ward explained that flaws in castings were eliminated by drilling them out if they were small, and brazing in a plug made to fit the hole. If they were large, and in the nature of a crack, if the crack was wide, a piece of any kind of iron was fitted into the space, and brazed into place. If narrow, the crack was cleaned out thoroughly and brazed up. If it could not be cleaned in this way, the fracture was extended by hammering, until the entire break could be reached to clean, even if this involved breaking the piece entirely in two. The cost of the "ferrofix" involved was about half a cent per square inch of surface brazed.

In tests made for the Government in Berlin, at the Stevens Institute in Hoboken, at the University of California, and by the Pennsylvania Railroad, it had been demonstrated that the brazed joint was not only stronger than any portion of the casting of equal section, but that the strength of the iron adjacent to the joint was increased perceptibly.

With the practice in Europe in mind, Mr. Ward asserted his belief that the introduction of this brazing process must affect shop practices as radically as was the case there. As the result of his investigations in Germany, France and Belgium, Mr. Ward stated in his judgment at least 75 per cent. of the flaws that ordinarily destroy the value of a casting could be eliminated, and the piece made sound and serviceable at a small fraction of the cost of remolding. Several small pieces were exhibited, but as there were no means of testing the strength of the joint, it could not be determined just how satisfactory the joints were for strength, although to all appearances the pieces were as sound and strong as if they had been molded perfectly.

The chief peculiarity of this process of brazing is that it is always perfect when the work is properly done. Its simplicity and cheapness were remarkable in view of the fact that in brazing steel or brass an expert in that art is usually required, in order to insure having a good job, but in "ferrofixing" by the American Brazing Company's process no expert skill was required. The alignment of the piece was unchanged, the surfaces, whether machined or not, were not disturbed in any way, and after the completion of the brazing operation all that was necessary was to clean off the surplus brass, and the piece would be found as sound and true as a perfect casting.

BOOKS AND PAMPHLETS.

Transactions of the American Society of Mechanical Engineers. Vol. 23. Annual Report for the 44th and 45th Meetings. 878 pages, illustrated. Published by the Society, from the Library Building, No. 12 West 31st St., New York City.

This volume contains the reports presented at the New York meeting of the Society for 1901 and at the Boston meeting for 1902. An interesting list of subjects is presented, the most important among which are the reports of the committees on standardizations and upon the Bursting of Flywheels, by Mr. Benjamin; but it is to be noted that reports and investigations upon railroad subjects are conspicuous for their entire absence.

Index of Proceedings of the Master Car Builders' Association. From Volume I. to Volume XXXIV., Inclusive. Compiled by George L. Fowler, J. W. Taylor, Secretary, 667 Rookery Building, Chicago, Ill. Price, by mail, $1.10.

This volume of 244 pages presents a complete and satisfactory index of the valuable work of this association, rendering its reports, papers and discussions available in a way which was impossible before because of the difficulty of finding desired information. The association is to be congratulated upon this index itself and upon the admirable manner in which it was prepared. The work was done by Mr. George L. Fowler under a committee of the following members: Messrs. D. F. Crawford, F. M. Whyte and W. A. Nettleton.

Metallurgical Notes. By Prof. Henry M. Howe, Columbia University. Published by the Boston Testing Laboratories, 446 Tremont Street, Boston, Mass. Price, $2.50.

This book marks a distinct step forward in the progress of instruction in metallurgy, and gives a carefully planned series of experiments which cover many of the fundamental principles. The experiments are so arranged as to compel the greatest amount of thinking and of careful and exact observation, and to reduce to a minimum the play or mechanical side of laboratory practice. Much general instruction is also given, and the reasons for each step are stated clearly and concisely. References are given copiously, and a good index makes the book useful for reference. We heartily commend it to every student of metallurgy.

American Railway Engineering and Maintenance of Way Association. Proceedings of the Third Annual Convention, 1902.

This volume contains the rules and record of business, lists of subjects and committees, in addition to the proceedings of the convention of last spring. Among the papers are several of special value, as follows: "Improvement of Grades and Alignment"; "Ties, Timber Supply, and Preservation of Wood"; "Rail Sections, Yards and Terminals, and Coaling Stations." There are also other important papers, but these are mentioned as being specially worthy of preservation. Thoroughness and business-like procedure characterize the work of this organization, and its proceedings constitute the best available record of present practice in maintenance of way. Presumably copies of the pamphlet may be obtained from the secretary, Mr. L. C. Fritch, Room 1562, Monadnock Block, Chicago, Ill.

Smithsonian Institution, Annual Report of the Board of Regents Showing Operation of Institution and its Present Condition. 782-pages, 8vo, profusely illustrated, with insert plates. Published by the Government Printing Office, Washington, D. C. For sale at cost.

This popular volume for 1901 contains fifty articles nearly all prepared by masters of the respective subjects, telling in clear and interesting language of the latest progress in all the principal branches of knowledge. "Bodies Smaller than Atoms," "The Greatest Flying Creature," and "The Fire Walk Ceremony of Tahiti," give evidence of the wide range of subjects included in the report. Wireless telegraphy, transatlantic telephoning, and the telephonograph are discussed by experts in electrical progress. Attention ought also to be called to papers on utilization of the sun's energy, the Bogosloff volcanoes of Alaska, forest destruction, irrigation, and the submarine boat.

Graphic Method of Solving Certain Questions in Arithmetic or Algebra. By George L. Vose, Professor of Civil Engineering in Bowdoin College. Van Nostrand Science Series. Second edition. 62 pages, with numerous diagrams. Price, 50 cents.

This is a second edition of the reprint of the valuable article which appeared in Van Nostrand's Engineering Magazine for June, 1875. The method described is the one that originated in and was suggested by simple mechanical movements, but was shown to be applicable to very intricate and complicated movements, and has been used to a very large extent for a great many years by railroad companies for the adjustment of the running times of trains. The method set forth is too well known to need comment, being still in use on a large number of the prominent roads of this country. This second edition of the work will bring it again into print, so that it will be available for those not familiar with it.

Mechanics Problems. For Engineering Students. By Frank B. Sanborn, Professor of Civil Engineering in Tufts College. 8vo, 155 pages, illustrated. Published by the Engineering News Publishing Company, New York, 1902. Price, $1.50.

This volume presents a very complete list of 500 problems, with answers, relating to applied mechanics. They are similar to problems presented in many text-books, but many of these have been developed from the conditions of actual practice, and thus are intended to fulfill all requirements for thorough and interesting instruction in the applications. This volume is not intended to take the place of text-books or lecture notes, but rather to be used in conjunction with them, in order to correlate more closely the every-day practical examples with the important laws of mechanics. The problems have been arranged by subjects in the following order, Work, Force and Motion, which order is considered the best. A very complete and well-arranged index to the problems is appended.

Manual for Steam Engineers and for Owners of Steam Apparatus *(Manuel du Chauffeur-Mecanicien et du Proprietaire d'Appareils a Vapeur)*. By Henri Mathieu. *Controleur Principal des Mines, Inspecteur des Appareils a Vapeur de la Seine*, etc. Second edition, entirely revised and considerably enlarged. 892 8vo pages. Printed in French. Profusely illustrated. Published by Ch. Beranger, 15 Rue des Saints-Peres, Paris, France.

This is a very complete treatise on the subjects of steam, steam generation and steam engines, with particular reference to modern French practice. No pretentions are made toward a scientific treatment, the work being addressed more to practical men and toward a practical, though very complete, treatise on apparatus. The work is divided into three parts—Boilers and Receivers; Engines, Valves, etc., and Laws and Legislation governing the use of steam. Only a few pages are devoted to the locomotive, the work being essentially devoted to stationary practice, but as an exposition of the details of engines and steam machinery it is not to be excelled.

Machine Shop Arithmetic. A Pocket Book of Practical Problems. By Fred H. Colvin and Walter L. Cheney. Third edition, 1902. 131 pages, with diagrams and tables. Published by the Derry-Collard Company, 256 Broadway, New York. Price, 50c.

This valuable little work has been revised and enlarged to bring it up to modern practice in every particular. It contains chapters on the foundation principles of arithmetic, on square root, cube root, and principles of screw-cutting in lathes, in which, instead of giving just rules and examples, it is endeavored to show *why* each step is taken, so as to assist the reader in reasoning out problems instead of following rules implicitly. Explanations in clear language of the principles on which the methods of solution are founded are characteristic of this book, and are what give it especial value. We cannot refrain upon commenting also upon the artistic manner in which the binding and typographical work were handled; the quality of the paper is excellent and the binding is very attractive. The high-grade work exhibited in this little volume bespeaks a bright future for the Derry-Collard Company, of which Mr. Colvin is president.

The Design of Simple Roof-Trusses in Wood and Steel. With an Introduction to the Elements of Graphic Statics. By M. A. Howe, C. E., Prof. of C. E. at Rose Polytechnic Institute. 129 pages. 8vo, illustrated. Published by John Wiley & Sons, 43 East Nineteenth Street, New York. Price, $2.

This book was written to bring together into small compass all the essentials required in properly designing ordinary roof-trusses in wood and steel. At present such information is widely scattered and does not exist in a single book, so that it was thought this work would fill a long-felt want for students of engineering who have not devoted particular attention to civil engineering studies. It will, however, do more than this—it will meet the demands of the great number of those who have not had the advantages of a technical education, as it gives clearly and concisely all the information necessary and, besides, presents three actual examples of complete designs for wood and steel roof-trusses all

worked out in detail for a guide to future designs. It contains very little mathematics that cannot be easily comprehended, and gives in the appendix a large list of tables regarding roof coverings, the various structural materials and properties of the various commercial shapes. This work is arranged in the convenient and practical manner that we like to see, and is highly recommended to anyone desiring such information.

A Manual of Drawing. By C. E. Coolidge, Assistant Professor of Machine Design, Sibley College, Cornell University. 92 pages, 8vo; 10 full-page plates. Published by John Wiley & Sons 43 East Nineteenth street, New York. Price, $1.

Probably no branch of engineering has had more books written about it than that of mechanical drawing, and with more indifferent success. The great majority of such books are mere compilations into book form of the methods of teaching the subject of some instructor, without purpose other than that of presenting the entire subject in restricted space, with the result that too little of any part is given. The above-named book by Mr. Coolidge is not an attempt to cover the whole field, but is a small work of 92 pages with a definite purpose to fulfil, viz., that of presenting to students a single-standard drafting-room system. It is impossible to present this subject by lectures in the class-room without more or less confusion to the student, and so the object sought here is to present a single system and to do it thoroughly and well. The first 80 pages of the work are taken up with an exposition of standard drawing materials, instruments and methods of using them; the remainder is devoted to instructions regarding commercial mechanical drawings, and is accompanied by 10 full-page plates at the back of the book. The work is regarded by the author as incomplete, for which reason every other page is left blank to permit the addition of notes as found necessary. This book is a step in the right direction to reclaim the technical graduate of the future from his present state of educated helplessness and substitute the practical education so universally desired.

The Derry-Collard Company, of 256 Broadway, New York, have issued a 44-page pamphlet giving a carefully selected list of books for railroad men. The method pursued by this company is to send any book desired, on approval, to be paid for if retained and to be returned if it does not prove to be the one wanted. The pamphlet gives the titles of books, the prices and a brief statement of the character and value of the work. It would pay the railroads of this country to supply their mechanical department drawing rooms with books from this list.

Motor and Trailer Trucks.—This is the title of Record of Recent Construction No. 38 of the Baldwin Locomotive Works, which describes the development of the electric motor trucks of those builders and illustrates a large number of trucks for American and English passenger service of elevated and underground roads and also for the heavier class of electric interurban service. This firm have applied to the construction of these trucks their long experience in locomotive work, and the pamphlet is an interesting record of their progress and practice.

The Ferguson Portable Heater and Kindler is described in a pamphlet received from the Railway Materials Company, Old Colony Building. This device has been on the market only two years and has been adopted by 38 railroads in the United States for many important operations in connection with car and locomotive repairs. The machine consists of a tank mounted on wheels, which is connected to a source of supply of compressed air, and a very hot flame is produced by a portable burner attached to a hose, the flame of which is produced by the combustion of air and the cheapest grade of crude petroleum. The portability of the machine and the convenience in operation and regulation render the device exceedingly convenient for emergency roundhouse repairs, such as heating locomotive frames for bending, straightening bent ashpans, shimming tires, heating tires for removal, and similar work. The heater is also used in repairing steel cars where an intense local heat is required for bending distorted plates and members. Another use is lighting fires on locomotives. The remarkable success obtained by the Ferguson furnaces manufactured by this concern is sufficient guarantee of the success of this new device.

"Jeffrey Water Elevators" is the title of a recent special catalogue from the Jeffrey Mfg. Company, Columbus, Ohio, illustrating and describing various systems of raising water developed by them. Chain bucket water-elevators for operation by power are shown geared for horse-power or other driving methods.

Steel as a substitute for wood in laths is making rapid progress in building construction. The Cambridge Rigid Reversible Metal Lath is made of steel and is well suited for either inside plaster or outside cement construction. It is proof against fire, damp, cracks, vermin and sound. For inside work it is permanently protected by the plaster and for outside work permits of cement construction, giving the appearance and durability of stone. This lath is the subject of an illustrated folder received from the American Sheet Steel Company, Battery Park Building, New York, the manufacturers.

The Rand Drill Company, 128 Broadway, New York, have issued a new catalogue of "Imperial Air Compressors." This pamphlet contains a thorough description, with detailed information, of "Imperial," Type 10 and Type 11 air compressors. Type 10 is a horizontal machine, combining the many special features of the machinery of this firm, and Type 11 is a vertical machine to meet requirements of compactness, simplicity and strength. The "Imperial" unloader is also described. Tables are included, giving the capacity, indicated horse-power, dimensions and weights of these machines in various sizes.

Thread milling machines are described in an illustrated catalogue which the Pratt & Whitney Co. have prepared for distribution. This is a comprehensive pamphlet, of which the company should be proud. It presents the subject of thread milling, describes the machine, illustrates the proper method of driving it, and shows by beautiful engravings the product which it will turn out. The object was to produce a method of cutting threads which will be better, more accurate and more economical in performance than the engine lathe methods which have been used for thirty years. The following results were sought: Uniformity, exact pitch, smooth finish, large output, low cost, and these to be secured with unskilled labor. The saving made possible by thread milling is estimated at from 25 to 500 per cent. The pamphlet opens with a clear and concise description of the machines, the cutters, fittings and driving mechanism. It then presents engravings of the product, including threaded rods, solid end springs, worms and spiral gears. Following these are tables of gears for English and metric threads, tables for setting the cutters, and the pamphlet closes with an illustrated description of the automatic cutter-grinder designed specially for these machines, which renders the sharpening of the cutters an easy task. This is an important addition to the product of the firm, and the presentation in the pamphlet is in every way worthy. Better engravings are not to be found anywhere, and in other respects the pamphlet is an example to machine-tool builders.

The name of the Broderick & Bascom Rope Company, of St. Louis, has been long associated with successful practice in the use of wire ropes, and any contribution from them on this subject commands attention. A handsome pamphlet entitled "Underground Wire Rope Haulage" has just been prepared for them by Mr. William E. Rolfe. It presents the successful application of this system in the workings of the Coal Valley Mining Company, at Sherrard and Cable, Ill., and is one of the best examples of literature of this kind that we have seen. The pamphlet shows the relation between wire-rope haulage and the output of mines, especially in the fact that it provides an inexpensive and effective method of collecting the cars to a central point. The conditions of mining require absolute reliability, and that is given by this method. Three systems are described—the inclined plane, the endless rope, and the tail rope. These are illustrated by excellent engravings made from flashlight photographs taken in the mines. The descriptions are of actual construction, and the commercial question of comparison between mule and rope haulage is presented. This pamphlet will interest mine officers and also engineers who are engaged in work requiring wire ropes for any purpose. An interesting case of an old rope, after it had been in continuous service for four years, is illustrated. The address of the Broderick & Bascom Rope Company is 809 North Main street, St. Louis, Mo. Copies may be had on application.

"Tropenas" steel castings are described and illustrated in a pamphlet received from the American Brake Shoe and Foundry Company. This process of making cast steel is specially adapted to the manufacture of small castings which may be used in place of forgings and malleable and gray iron castings. In the pamphlet the process is described and the merits of this steel are set forth. On every page is an engraving illustrating a very large variety of castings for which this metal is used. As a substitute for forgings this metal saves the labor of forging; as a substitute for malleable and gray iron forgings it offers a better material, with greater strength and ductility.

The monthly publication, Dixon's Graphite, for December, contains an interesting article on experiments by Prof. W. F. M. Goss, of Purdue University, in the use of Dixon's graphite in air-brake equipment. The experiments were made upon the 50-car train equipment at the university. The experiments covered the use of vaseline without graphite, graphite without vaseline, and finally the use of graphite and vaseline. The experiments are not only of interest but of value to all who are connected with or interested in locomotive engineering. The important conclusions of the test may be stated as follows: 1. Graphite alone is not a sufficient lubricant for triple valves. 2. After graphite has been well rubbed into the working surfaces of the valves, and after this process has been followed by thorough oiling with vaseline, the action of the triples was more delicate and more rapid than with vaseline alone, prior to the use of the graphite. 3. The presence of the graphite on the metal surfaces of the valves, when operated with vaseline as a normal lubricant, serves to improve their action in a marked degree.

The Crane Company, Chicago, Ill., have recently issued a pocket edition of their complete catalogue. The contents are practically identical with those of their recently issued general catalogue, their standard-pressure valves and cocks in brass and iron being illustrated and described, as well as their very complete line of fittings, their high, medium and low-pressure fittings, gate valves and flange fittings, and engineers', steam and gas-fitters' tools and supplies. This little volume, which is 4½ by 7 inches in size, has 464 pages, and is bound in buckram, making it a very serviceable handbook. It is now ready for distribution, and may be obtained by writing to the home office or to any of the branch offices of the company.

The Case Steam Engine.—The New Britain Machine Company, of New Britain, Conn., have prepared a 40-page pamphlet illustrating and describing the Case automatic high-speed engine built by them. This engine is constructed in three forms, all embodying the same principles. The first is a pedestal engine, for attachment to a floor or foundation; the second is a bracket engine, to be bolted to a wall, and the third is a hanger engine, a novelty originated and manufactured by this company, to be bolted to an overhead beam. These engines are built in a large variety, and are specially adapted to use in direct-connected generator sets. The pamphlet is one of the most complete we have seen on the subject of the small steam engine, and in it are illustrated a number of interesting applications. Copies of the pamphlet may be had upon application.

The Gates Rock and Ore Breaker is well known all over the world for its simple construction, great capacity and durability. Over 5,000 of these machines are now in use in all parts of the civilized world. This statement alone is sufficient ground for implicit confidence in this machine and the concern manufacturing it. Under the title of "Mining Machinery" the Allis-Chalmers Company have issued three pamphlets devoted to these crushers, and they should be in the hands of everyone requiring crushing machinery. Book No. 1 illustrates and describes the construction of the crushers in detail, and also presents the new "Style D" machine. The Gates works have been engaged for twenty years in the manufacture of gyratory crushers, and during that time they have not lost an opportunity to apply their intimate knowledge of the requirements of this class of machinery to its improvement. The word "gyratory" indicates the character of the mechanism. The material is crushed between a cone upon a gyratory shaft and a shell which forms a part of a very strong case. The shaft is vertical and its upper end is rigidly held in a bearing while the lower end is gyrated by means of a gear-driven eccentric. The crushing cone impinges against the sides of the shell, its motion causing it to continually approach and recede. The crushing is done against a concave surface of the shell, which tends to make the broken parts take a cubical form. This form of machine, owing to its circular construction, has about three times the capacity of the jaw type of machines. Other advantages claimed for it over the jaw machines are finer crushing, absence of vibration, and much less power required for driving. For crushing ballast and preparing broken stone for concrete these machines are specially well adapted. They are made in sizes up to a capacity of 150 tons of road material per hour, and these operate at a cost of less than 2 cents per ton. This concern also manufactures sample grinders, fine crushers, hoists, screens, and everything pertaining to this class of machinery. Book No. 4 describes complete crushing plants, and another pamphlet contains a list of users of the machines and letters reporting satisfactory operation. One prominent feature of these is the testimony with reference to durability and low cost of repairs. Farther information may be had by addressing the Allis-Chalmers Company, Chicago, Ill.

INDUSTRIAL NOTES.

The Q. & C. Company have shipped from their factory at Chicago Heights, Ill., one of their largest special metal sawing machines to the United States Government, to be used at the navy yard at Cavite, Manila.

H. B. Underwood & Co., manufacturers of special tools for railway repair shops, 1025 Hamilton street, Philadelphia, inform us that Mr. Daniel W. Pedrick is no longer connected with or interested in any way with the Pedrick & Ayer Company. His entire time is now given to H. B. Underwood & Co., of which firm he is the senior partner. He has been a partner of this firm since its organization and is now engaged in manufacturing portable cylinder boring bars and other portable tools for railroad shops, of the same high grade and quality as he did when connected with the Pedrick & Ayer Company.

The Stewart Hartshorn Company, February 1, will move their New York stock rooms to No. 7 Lafayette place, one block east of Broadway, between Great Jones street and East Fourth street, a central location for all interested. For the past thirty-four years Hartshorn shade rollers have been in stock at 486 Broadway, a location well known to the trade, and although it is a rare thing to see old firms move, it was deemed best by the company in this case. Trade has been increasing, as well as demands for the many improvements which the company has brought into the construction of their shade rollers and accessories, so that in order to carry the necessary stock for immediate shipment in New York it was found necessary to acquire much larger storerooms. At No. 7 Lafayette place the main storeroom is on the ground floor, besides which the company will also occupy the basement, which is equal in area to the main storeroom. This gives more than double the space formerly occupied so long on Broadway, and here will be carried a full line of new groove tin and improved wood rollers, as well as the older styles of Hartshorn shade rollers, which are still called for by some dealers. Besides these, a full line of shade-roller brackets, pin ends, shade clasps, bottom roller clips, catch pulleys, etc., will be found; also models showing the various methods of placing shades properly in position. To these new stock-rooms the Stewart Hartshorn Company cordially invite their friends. With more room and fuller stock, quick demands can be promptly met. In future, as in the past, large shipments will be made directly from the company's factories in East Newark.

WANTED, A POSITION, after January 1st, 1903, by an architect and civil engineer; thoroughly conversant with the designing and detailing of large buildings and railroad shops. Will refer, by permission, to the Lake Shore Railway shops, at Collinwood, Ohio, a description of which is now being published in The American Engineer. Address M., care Editor American Engineer, 140 Nassau street, New York.